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EVALUATION OF HEARING LEVELS OF RESIDENTS LIVING NEAR A MAJOR AIRPORT

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FINAL REPORT

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16. Abstract Audiograms and other data related to ear conditions and noise exposure were obtained from residents drawn from two neighborhoods in the greater Los Angeles area. One community bordered Los Angeles International Airport and had been subjected over the years to frequent takeoff noise of high level. Maximum rms measurements of these aircraft sounds outdoors in this neighborhood ranged from 76 to 101 dBA with a median of 88 dBA. The second community was similar to the airport one in demography but free of significant aircraft noise intrusion. Noise levels here rarely exceeded 60 dBA and commonly were 50 dBA or less. Data from participants were screened to exclude those persons whose hearing could have been impaired by ear disorders or undue noise experience apart from the subject community noise conditions. Comparisons of the mean hearing levels by age, sex and right and left ears for the two neighborhood groups yielded variable, typically small differences. At low frequencies on the audiogram, the direction of these differences was equivocal, but at the high frequencies there were trends suggesting poorer hearing for the airport area residents. The hearing data for the airport neighbors also showed more variability than that for the control residents. Statistical testing could only partially confirm the significance of these differences in means and measures of variability between the two neighborhood groups and did not demonstrate any notable correlations between length of community aircraft noise exposure and hearing level. Both groups displayed average hearing levels as good and at certain frequencies slightly better than estimates obtained from the National Health Survey of 1960-1962. The overall findings did not make it possible to draw firm conclusions about community aircraft noise exposure as a cause of the apparent differences in hearing levels between the two groups.

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FOREWORD

This study is a first attempt to characterize the hearing of persons residing in an airport neighborhood subjected to frequent operational aircraft sounds. The project was sponsored by the Federal Aviation Administration (FAA) and directed via inter-agency agreement, by the Public Health Service (PHS). Initially, Mr. Raymond Shepanek, Office of Environmental Quality, and later, Mr. Thomas Higgins, Office of Noise Abatement, served as FAA Technical Representatives. Dr. Alexander Cohen, National Institute for Occupational Safety and Health, PHS, acted as the Project Officer with Mr. Thomas Anania and Mr. Stephen Cordle lending support in certain noise measurement phases of the investigation. Mr. Kenneth Busch, National Institute for Occupational Safety and Health, provided assistance in the statistical evaluations of the data. The contractor for the project was Environmental Acoustics, Chatsworth, California.

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INTRODUCTION

The heavy volume of jet air traffic at major airports in the United States and elsewhere exposes surrounding neighborhoods to frequent and significant fly-over noise and other operational aircraft sounds. Adverse community reaction to these noise intrusions is now well documented (1-4). This has prompted several approaches toward alleviation of aircraft noise disturbance. One has been to reduce jet aircraft noise at the source through engine redesign and improved acoustic treatment of nacelles (5-7). Another has involved certain changes in airport operations and in-flight aircraft operating procedures intended to minimize the frequency and level of fly-over noise produced in neighborhoods adjacent to airports In some instances, surrounding residential properties have been purchased and reallocated for non-residential land use. Still another effort has entailed investigations of human response to aircraft sounds for the purpose of defining tolerance limits or acceptance levels for such noise exposures (1-4, 8-10). The latter determinations represent the goals for the noise reduction measures noted above.

The human response research connected with aircraft noise has concentrated on measures of speech interference, disruption of sleep, and judgments of relative annoyance or acceptability. This is to be expected since these obvious factors are usually referenced in complaints of aircraft noise annoyance. Whether community aircraft noise exposure can also cause hearing sensitivity changes, admittedly a less obvious, insidious effect of noise exposure, has not been considered in the context of these evaluations.[1] It is the question under study here.

Noise-induced hearing loss constitutes a significant hazard in industry where workers may be exposed to intense noises for prolonged periods each work day. Airport workers, particularly those servicing aircraft, can experience such conditions. Figure 1, for example, compares the range of sound levels in dBA for noises encountered in airport loading

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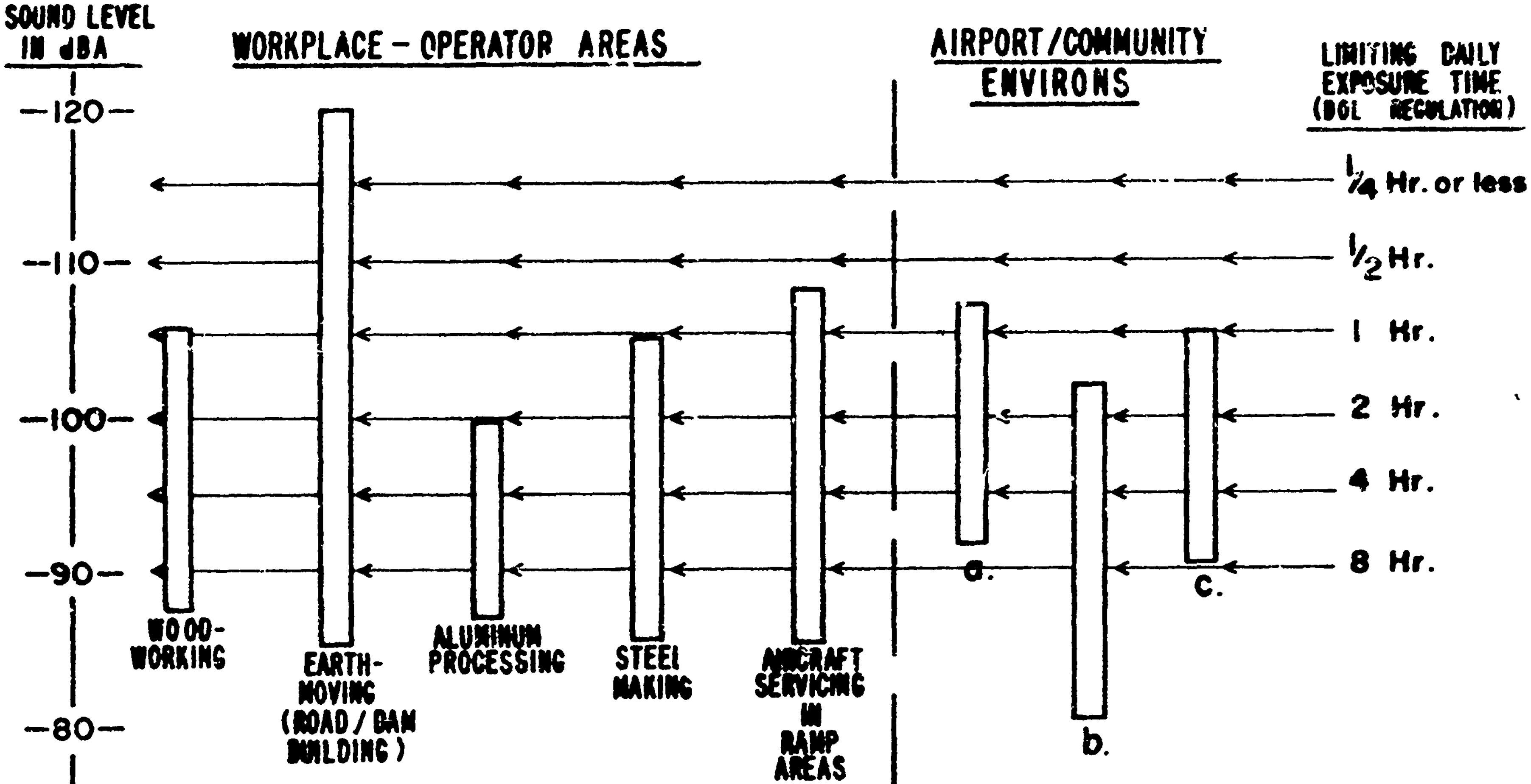
1. In actuality, there exist some cursory observations with an indication that persons living on a block adjacent to a small airport with frequent ground run-up operations on jet engines had poorer hearing relative to both National Health Survey data and that of neighbors who spent most of the day away from this area (15). These observations were not extensively documented.



Note: Sound levels for industrial operations were taken from PHS survey data. Aircraft fly-over data were collated from assorted references in the acoustic literature. The aircraft sounds were originally reported in perceived noise level and reduced by 13dB to yield equivalent dBA values.

a. Approach noise at 1 mile from runway threshold (92-107 dBA)
b. Take-off noise at 3.5 nautical miles from start of roll (81-101 dBA)
c. Side-line noise at 1/4 mile from runway (92-105 dBA)

Figure I. Range of Noise Levels in dBA from Operating Equipment in Workplaces and from Aircraft Flyovers in Airport Neighborhoods in Relation to Federal Occupational Noise Exposure Limits.

and maintenance areas with daily time limits for safeguarding hearing against workplace noise as cited in a Federal labor regulation (11)[2]. Also shown for reference are ranges of noise levels found in other jobs and work environments. These assorted occupational noise conditions readily attain levels necessitating restrictions on exposure time in order to meet the imposed limits for preserving hearing. Most occupational exposures, owing to their sustained nature, can exceed these noise level-time limits and therein pose a hearing loss risk to unprotected ears. Surveys have already confirmed increased prevalence of hearing impairment in workers involved in several of the job operations shown in Figure 1 when compared with persons in quieter work (12-14).

Also plotted in Figure 1 are ranges of maximum sound levels in dBA measured outdoors for aircraft operations observed at the boundaries of airport neighborhoods. These outdoor levels reach values indicating a need for reduced exposure time to offset any possible harm to hearing. Aircraft noise events in an airport community are of very short duration (less than 30 seconds within 20 dB of the maximum value) for the levels noted in Figure 1, and, though multiplied many times during the day, may not sum to a value exceeding the time limits for ear protection. Even if the summed exposure time to aircraft noise surpassed these limits, there is reason to suspect that the intermittent nature of the exposure would also reduce the potential harmfulness to hearing.

These considerations imply that community aircraft noise exposures do not endanger hearing. However, noises around busy airports, while intermittent, may be quite frequent and spread over a 24-hour day instead of confined to the 8-hour daily periods which are typical for industry. Ear tolerance for round-the clock noise exposure, either continuous or intermittent, is only now being investigated (16-17). In fact, all presently available criteria for hearing conservation are still related to the daily working hours and assume quiet surroundings for auditory recovery during off-job hours. Regarding this latter point, even if airport noise or other non-occupational noise exposures caused no threat of hearing loss, they could conceivably deprive a worker of a sufficiently quiet environment to allow hearing recovery from the more severe occupational noise exposures.

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2. Sound level readings in decibels observed on the A-weighting network of a sound level meter are termed dBA. This network provides a frequency-weighted measure of overall sound pressure level in that, akin to the ear, it is more responsive to middle and high frequency sound pressures relative to those of low frequency. Noise measurements in dBA show correlation with human reactions including hearing change, loudness and annoyance and, as such, are used in standards or proposed rating schemes for evaluating real or potential noise problems.

It should be noted also that existing industrial noise limits, as exemplified by those shown in Figure 1, are primarily aimed at preserving hearing in a restricted range of frequencies, namely 500 to 2000 Hz, which is believed critical to understanding everyday speech. Hearing for frequencies above this range, though even more noise sensitive, receives only indirect and limited protection. Further, adherence to industrial noise standards will not protect the entire population from developing hearing loss even for the critical speech frequencies. As much as 15% of the work force experiencing noise conditions rated as safe by the current Federal labor regulation may still suffer hearing impairment for speech sounds after 30 years of exposure (12,18). For these reasons, hearing loss risks from frequent or undue community aircraft noise exposures cannot be dismissed by judgments based on industrial hearing conservation criteria.

The present study sought to measure hearing level changes in residents living near a major airport with a high volume of aircraft traffic. This was to be assessed through comparisons with the hearing of persons living in a similar community free of significant aircraft noise exposures, and also with hearing data developed in national surveys. As a secondary part of this work, an attempt was also made to estimate the amount of noise exposure received by the airport residents as contrasted with that experienced by persons living in more typical neighborhoods. This overall investigation was deemed important in furnishing information in the interest of considering hearing conservation as well as acceptability criteria for aircraft noise exposures to which airport communities may be subjected.

DESCRIPTION OF AIRPORT AND CONTROL RESIDENTIAL AREAS SELECTED FOR THE SURVEY

AIRPORT NEIGHBORHOOD

Residents situated in the Playa del Rey "island" area (PDR) bordering the western boundary of Los Angeles International Airport (LAX) were selected as the aircraft noise exposed group for this survey. As seen in Figure 2, this area lies between the extended centerlines of the main south (25R, 25L) and north (24R, 24L) pairs of takeoff runways. Aircraft take-offs from each runway produce noise experienced throughout the "island" area.

There were 362 single-family homes located in this subject area covering about 16 square blocks[3]. Most of the houses in this section were constructed within the past 26 years although a few date back to the early 1930's. These residences are typically single-level structures with stucco exteriors built according to characteristic Southern California construction. Very few of the residences include air conditioning due to the close proximity to the beach, with moderate temperatures throughout the year. This means, of course, that windows are usually opened during the summer months. (This practice as well as outdoor activities, has become severely limited by the noise from the increasing number of jet over-flights. This adversely affects one of the more desirable aspects of this neighborhood).

Current census data were not available on the Playa del Rey area but the Los Angeles County Assessor's Office and real estate groups indicated that the population of the Playa del Rey island area numbered approximately 1,000 persons. Interviews with neighborhood association leaders suggested that the residents reflected a preponderance of so-called white collar occupations with most of the older residents being of upper middle class socio-economic status. The appraised value for the majority of homes found in this area ranged from $40,000 to $60,000. These appraisals were based on estimated values of the property in a comparable location free of the airport noise problems[4].

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3. The inhabited area, in question, is bounded by Avalonia Street on the north, Killgore Street on the south, Trask Street on the east, and the Vista del Mar on the west overlooking the Pacific Ocean.

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4. This information was obtained from the Los Angeles County Property Assessor's Office and the planning section of the Los Angeles Department of Airports.

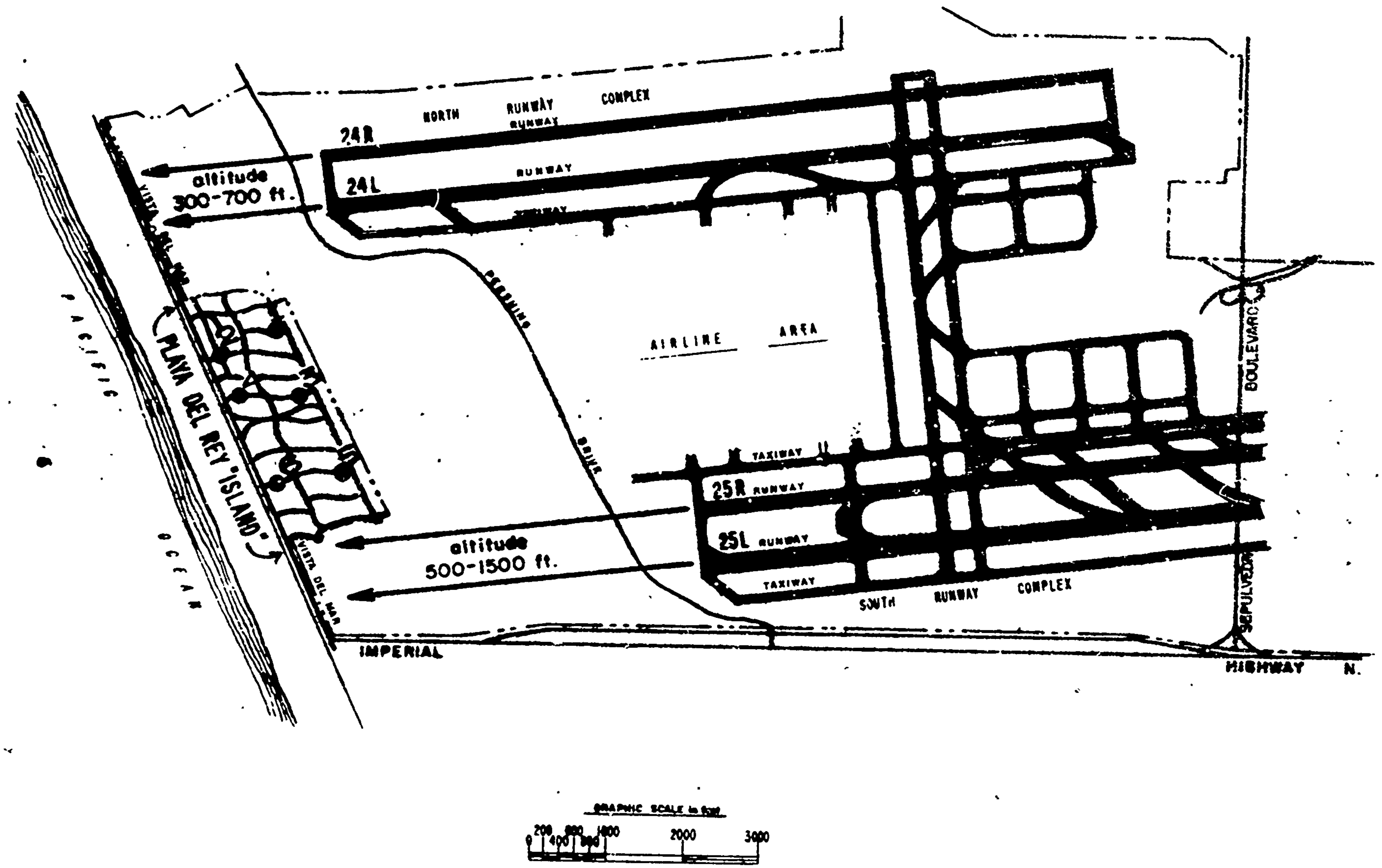

Figure 2. Map Showing Location of Airport Neighborhood (Playa Del Rey) in Relation to Flight Tracks at Los Angeles International Airport. Also shown are Measurement Stations (1-6) in the Community where aircraft sounds were monitored.

The first commercial jet operations affecting the "island" area began in January 1959 off the south runway complex (25R, 25L). The initial rate of one jet takeoff and landing per day rose within six months to 19 takeoffs and landings of jet-type aircraft each day. By the end of 1960 over 50 jet aircraft took off daily over the Playa del Rey community. The growth of operations from 1960 to 1969 was quite steady with a slight decline evident in early 1970. The number is currently rising again.

The average daily number of takeoffs during the years 1961 to 1970 is shown in Table I, including percentages of jet aircraft operations. It is noted that prior to 1967, only the south set of takeoff runways were in use. In 1967, the first of the north set of runways (24L) was opened, and on the average has handled about 20% of takeoff traffic since that date. In July 1970, the northern-most runway, 24R, became operational. It should be added that landings sometimes occur over the Playa del Rey community but comprise approximately 1% of total aircraft operations. For this reason they are not considered in this or subsequent assessments of the noise problem in the Playa del Rey area.

The magnitude of takeoff noise levels together with the frequency of such events in recent years (in excess of 500 per day) have produced an intolerable aircraft noise condition in the Playa del Rey community considered in this study. For this reason, the City of Los Angeles in 1970 approved condemnation of the island area with all residential structures to be acquired by the City and eventually removed. The survey of residents in Playa del Rey described in this report took place during the time period in which assessors were in the area to determine compensation for parcels of private property. Access to this population, soon to migrate elsewhere, offered a unique opportunity to study hearing levels of a group having experienced frequent high level exposures to jet aircraft sounds over a number of years.

CONTROL NEIGHBORHOOD

A beach community lying just to the north of Santa Monica in the Pacific Palisades region (PP) was chosen as the control neighborhood for sampling a comparison test group for the hearing evaluation required in this survey[5]. The exact boundaries of this area are shown in Figure 3. Preliminary noise level observations subsequently confirmed by more extensive measurements (see next section) found this neighborhood to be free of significant noise intrusions from aircraft as well as other noise sources. In addition, the homes were similar in construction style and assessed values with those found in the Playa del Rey "island" area. Information gathered from realtors and local civic groups on the residents in this neighborhood suggested that they were comparable to Playa del Rey residents in socio-economic status and general demographic features.

5. This site appears to be somewhat north of the flight corridors noted in a recent report showing significant noise levels under LAX approach and departure routes (21). Aircraft fly-over noise, was lower in level and less frequent in the control area described here as compared with the aforementioned published data. The control area in question was bounded by Muskingham Avenue on the north, Northfield Street on the east, Erskine Drive on the south and Asilomar Boulevard on the west overlooking the Pacific Ocean.

TABLE I Average Number of Daily Takeoff Operations from the North and South Runway Complexes at LAX During the Years 1960-1970.

YEAR	TOTAL AVERAGE TAKEOFFS DAILY (ALL AIRCRAFT)	% JETS	TOTAL AVERAGE TAKEOFFS DAILY (JETS)	AVERAGE TAKEOFFS PARTITIONED BY RUNWAY AND TIME PERIOD			
				SOUTH (25R&25L)		NORTH (24R&24L)	
				DAY	EVENING	DAY	EVENING
1961	286.8	50	134.4	107.5	26.9		
1962	324.1	55	178.3	142.6	35.7		
1963	[illegible]4.8	60	212.9	170.3	42.6		
1964	363.9	65	236.5	189.3	47.3		
1965	364.9	70	255.4	204.3	51.1		
1966	404.4	75	303.3	242.6	56.7		
1967	478.4	80	382.8	260.3	65.1	45.4	11.5
1968	552.7	85	464.8	300.6	75.2	75.2	18.8
1969	563.3	90	507.0	324.5	81.1	81.1	20.3
1970	558.7	95	530.8	339.7	85.1	85.1	21.2

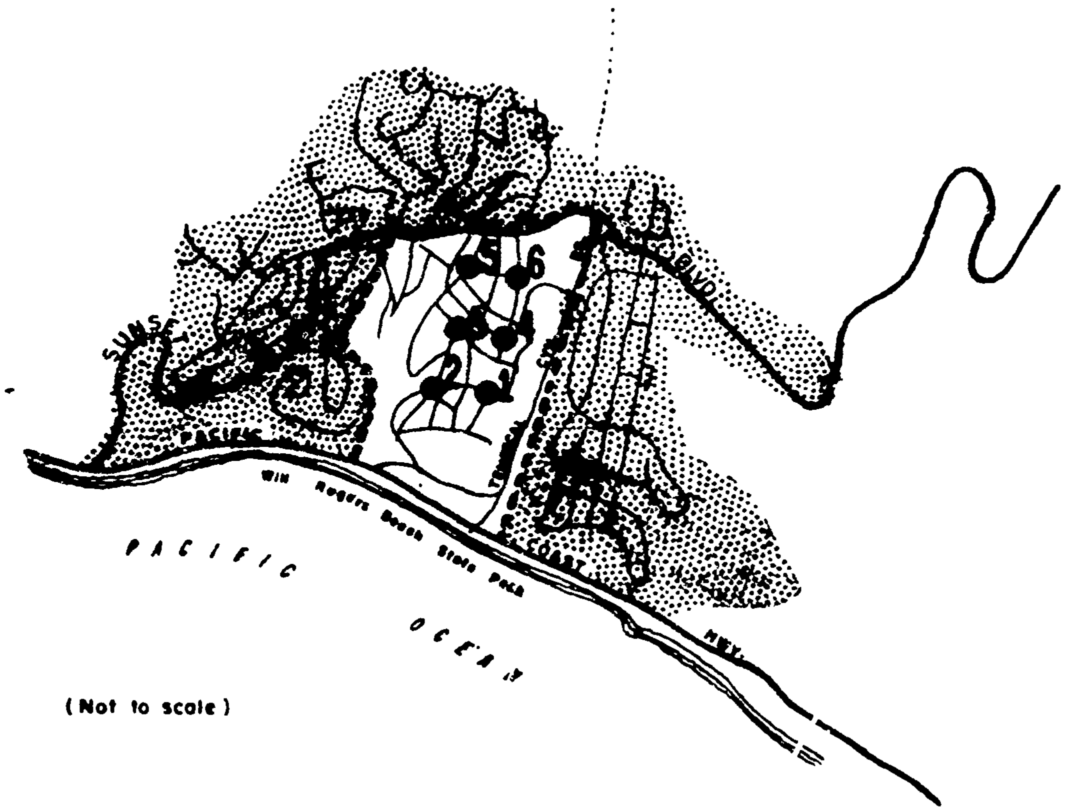

Figure 3. Map Showing Control Neighborhood in the Pacific Palisades lying North of Playa Del Rey and Los Angeles International Airport. Also shown are Measurement Stations (1-6) in the Community where ambient sound levels were monitored.

ENVIRONMENTAL NOISE EXPOSURE IN THE TEST AND CONTROL AREAS

NOISE MEASUREMENTS - AIRPORT NEIGHBORHOOD

Actual sound levels for individual aircraft fly-overs were measured at ground level outdoors in the Playa del Rey community. These measurements were taken by Public Health Service engineers at each of six locations in the island area as shown in Figure 2. The measurement data at each location allowed for subdivisions into exposures to aircraft sounds originating from movements from the north and south runway complexes. Distributions of the observed maximum sound levels in dBA are shown in Table II by individual locations and by pairs of locations corresponding to the north, central and south sectors of the "island" area.

These data were collected on three separate days, representing a total of 12 hours of observation time between the hours of 0800 and 1900.[6] A total of 1307 fly-over events were observed during this period. One set of observations were direct readings of A-weighted sound pressure levels from a General Radio 1565A Sound Level Meter. A second system utilizing a Bruel and Kjaer (B & K) 2203 Sound Level Meter and Kudelski Nagra III magnetic tape recorder was utilized to make direct unweighted recordings for subsequent laboratory analyses. These analyses included playback of the tapes through an A-weighting network to obtain sound levels for each fly-over event. A time history of these dBA levels was plotted at one second intervals for each of the discrete fly-over events recorded at each of the measurement stations. These time history plots were all normalized with (t_0) representing the maximum A-weighted sound pressure level achieved for each discrete event. All events were combined for the three pairs of measurement stations in line with the runways, i.e., 1 and 2, 3 and 4, 5 and 6 (see Figure 2). This resulted in three sets of composite time histories representing the average maximum rms A-weighted level occurring over the three sections of the Playa del Rey Island area. These aircraft noise exposure levels are shown in Figures 4, 5 and 6.

The Public Health Service data were supplemented by additional on-site measurements conducted by Environmental Acoustics personnel using a B & G 2204 Sound Level Meter system and Uher 4000L Magnetic Tape Recorder. In addition, mean values for indoor/outdoor attenuation were established in order to assess the noise exposure of residents indoors during over-flights.

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6. Plans for more extensive measurements of aircraft noise in the Playa del Rey area were curtailed at the request of the Federal Aviation Administration and the local airport authorities.

TABLE II Centile Distributions of Maximum RMS Sound Levels in dBA Resulting from Aircraft Overflights at Six Measurement Locations in Playa del Rey. (Also shown are the ranges of ambient noise levels in the absence of detectable aircraft sounds.)

CENTILE	MEASUREMENT LOCATIONS									
	1	2	3	4	5	6	AVG. 1 & 2	AVG. 3 & 4	AVG. 5 & 6	AVG. 1 - 6
95th	101	100	97	95	98	97	101	96	97	98
75th	95	93	90	89	93	90	94	90	92	92
50th	92	90	88	86	86	85	91	87	86	86
25th	86	85	84	83	81	81	86	83	81	83
05th	80	79	80	79	76	78	80	79	77	78
Range of Ambient Levels	45-47	43-49	48-50	50-54	48-52	52-56				

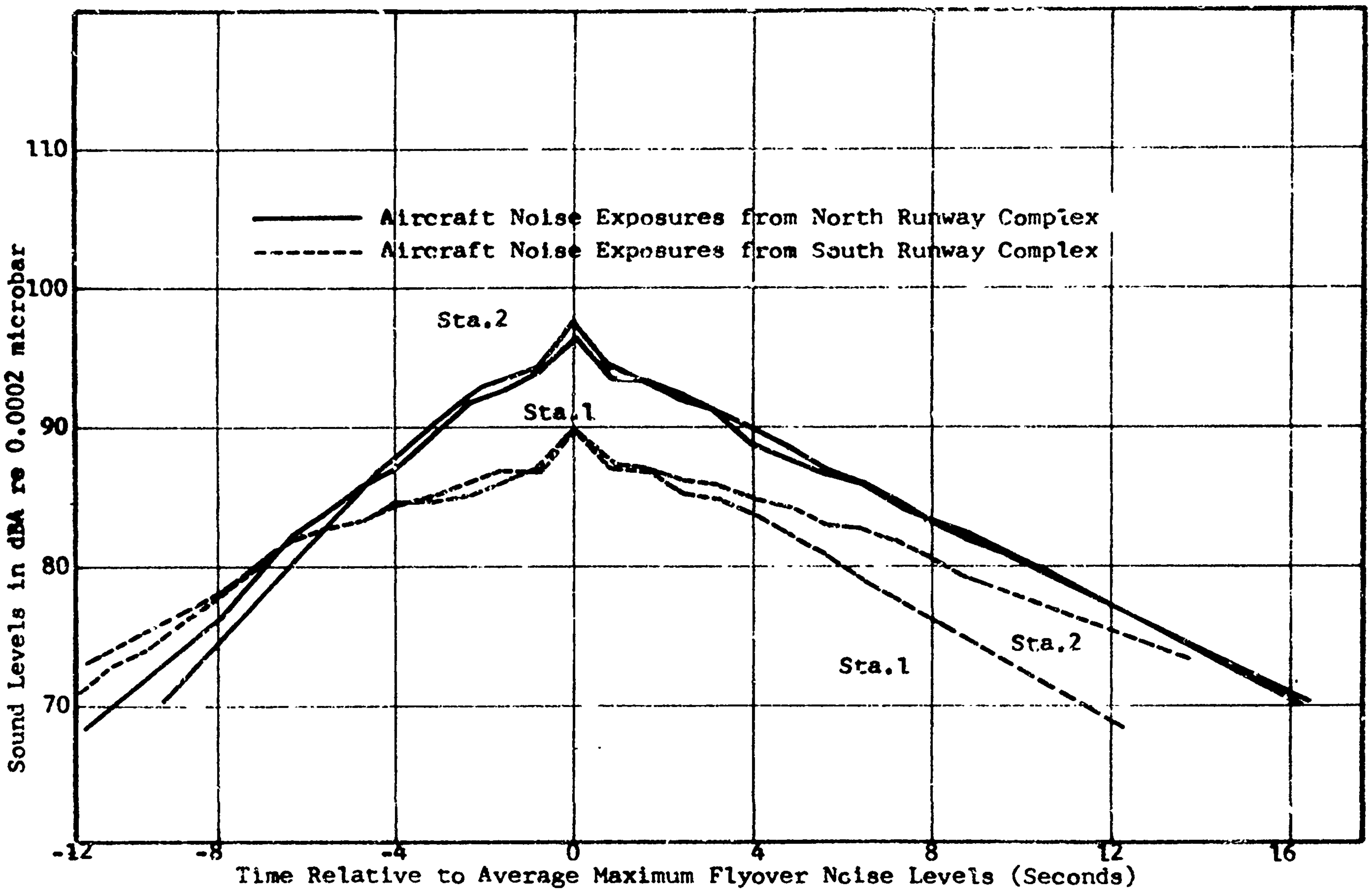


Figure 4. Composite Sound Pressure Time Histories for Measurement Locations 1 and 2 in Playa Del Rey. Maximum Flyover Noise Levels Normalized Prior to Averaging.

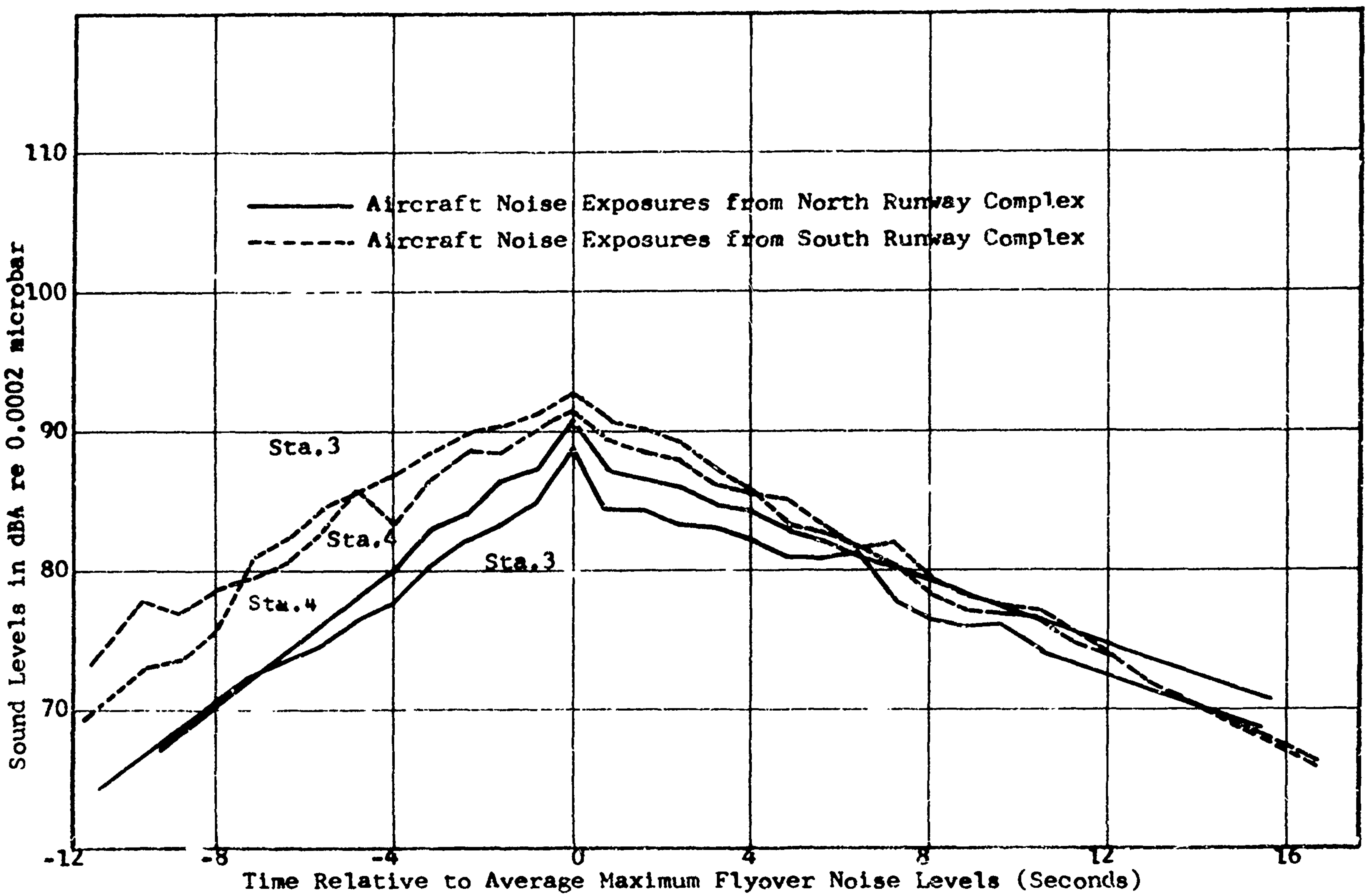


Figure 5. Composite Sound Pressure Time Histories for Measurement Locations 3 and 4 in Playa Del Rey. Maximum Flyover Noise Levels Normalized Prior to Averaging.

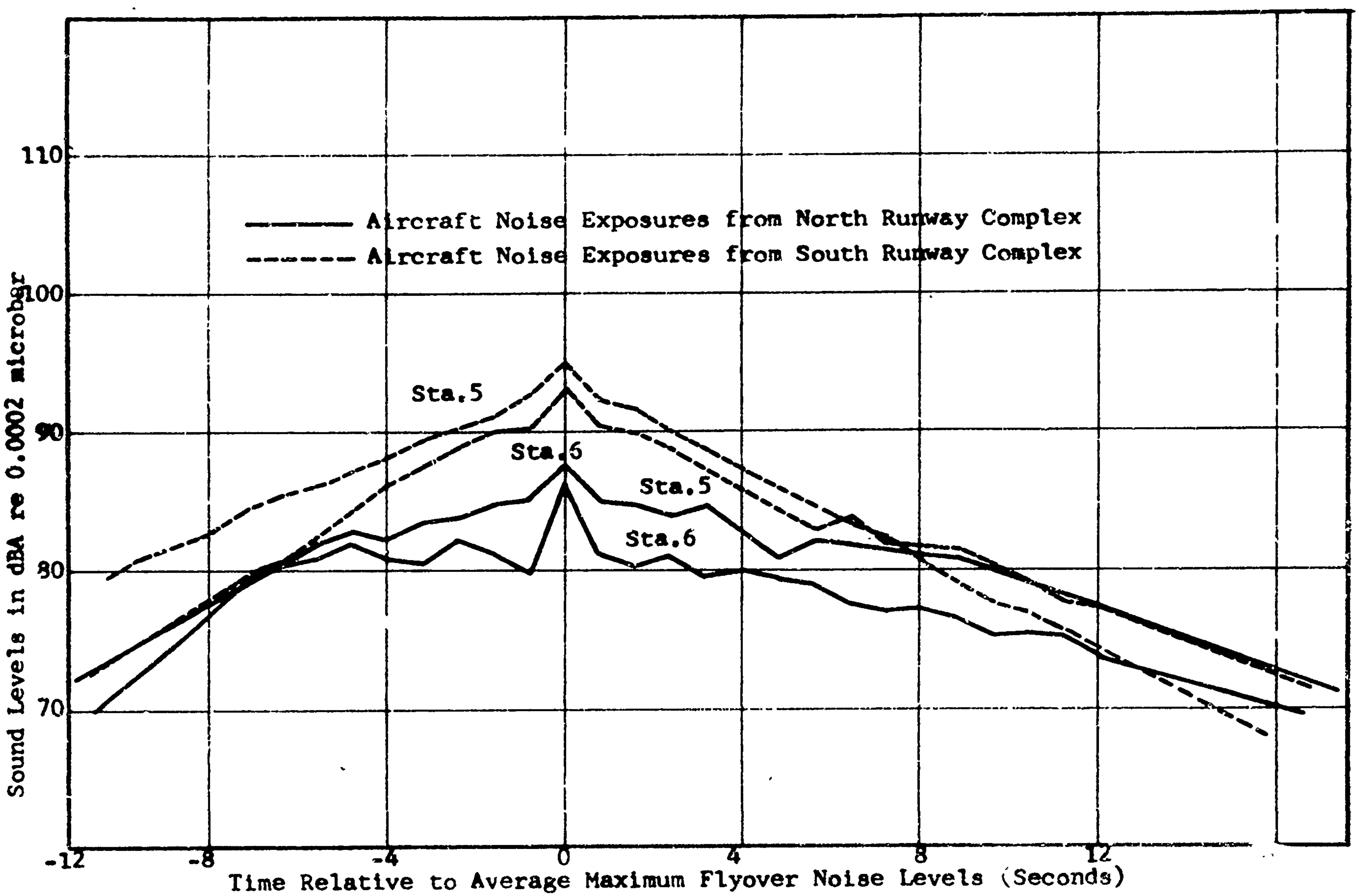


Figure 6. Composite Sound Pressure Time Histories for Measurement Locations 5 and in Playa Del Rey. Maximum Flyover Noise Levels Normalized Prior to Averaging.

EVALUATION OF NOISE EXPOSURE PATTERNS IN PLAYA DEL REY

Measurement locations 1 and 2 (Table II) receive the highest noise levels from the north runway complex at LAX (runways 24L and 24R). Locations . and 6 receive the highest levels from the south complex (runways 25L and 25R) while locations 3 and 4 receive about equally high levels from either complex. In absolute terms, locations 1 and 2 receive, on the average, the highest maximum noise levels (median or 50th centile value of 91 dBA). This occurs because aircraft from the north complex have not reached as great an altitude as those from the south complex relative to the measurement locations in the community. Operations from the south complex, however, comprise the majority of takeoffs at LAX. Consequently, in terms of total integrated noise exposure, the southern portion of the study area is the most heavily impacted.

As shown in Table II, the median values of the maximum sound levels for measured aircraft noise range between 85 and 91 dBA across the island area. These data, and those for other centiles shown in Table II, are representative of noise exposures in the community during the period since 1967 when Runway 24L was opened. The history of jet operations over the island area has been described previously. The frequency of takeoffs during the period 1961 and 1970 was summarized in Table I.

Noise exposure for particular individuals will depend not only on the outdoor noise levels and numbers of exposures but also on the degree of attenuation afforded by residential structures. It was, of course, impossible to measure attenuation afforded by each separate structure within the community. Work done previously by Environmental Acoustics (22), supplemented by measurements made during the course of the present work, have indicated that representative average values for indoor/outdoor attenuation are 12 to 14 dBA with windows open and 20 to 24 dBA with windows and doors closed, although variation around these figures will depend upon location of the particular structure within the community as well as differences in construction.

It is only grossly possible to estimate the total noise exposure for a person spending most of each day in the Playa del Rey community, both indoors and outdoors. In 1970, an average of one overflight occurred every 150 seconds during daytime hours. Referring to Figures 4-6, it is evident that the noise level for each overflight exceeds 80 dBA for approximately 20 out of every 150 seconds with average maximum levels of the order of 90 dBA. This represents an exposure to aircraft noise (outdoors) in excess of 80 dBA for a period of 3.2 hours per day. For a person indoors with windows open, the levels may be expected to exceed 70 dBA for approximately 20 seconds out of every 150 seconds. For the same person with windows and doors closed, the levels exceed 60 dBA for this same period throughout the day. Actual noise exposures

will, of course, represent some weighted combination of these exposure patterns since residents spend varying amounts of time indoors and outdoors. By comparison with 1970, noise exposures in 1965 were slightly more than 50% of current values.

AMBIENT NOISE MEASUREMENTS IN PLAYA DEL REY

Ambient noise levels in the test neighborhood (those normally present exclusive of unusual intrusive noises) are typical for a suburban community and range between approximately 40 to 50 dBA below the maximum sound levels observed during jet overflights. These levels vary between 43 and 56 dBA as a function of measurement time and location (See Table II).

AMBIENT NOISE MEASUREMENTS IN PACIFIC PALISADES

Noise surveys were conducted in the Pacific Palisades area to assess the typical noise exposures experienced in the neighborhood. These measurements were conducted at the six locations shown in Figure 3. Equipment used for these measurements was identical to that described previously. Approximately 5 hours of observation time was spent at each of the six measurement locations sampling morning, mid-afternoon and early evening periods during the day.

The predominant noise sources in the area are local surface street traffic, a nearby high speed surface street (Sunset Boulevard) and occasional high altitude (greater than 2000 feet) commercial jet aircraft fly-overs. These aircraft pass over Pacific Palisades after departing from LAX, making a turn back to the east while over the ocean, and climbing to a cruise altitude. Consequently, the outdoor noise levels experienced in the Pacific Palisades area are of the order of 70 dBA, substantially lower in level and much less frequent than those experienced in Playa del Rey (see also Footnote 5 on page 8).

Distributions of ambient noise levels measured in the Pacific Palisades control area during periods of quiet and peak surface traffic activity are shown in Table III. There is a close correspondence between the median values in the Pacific Palisades and the range of ambient sound levels observed in the Playa del Rey area in the absence of detectable aircraft sounds (see Table II).

TABLE III Centile Distributions of Ambient Community Sound Levels in dBA Measured During Periods of Peak Surface Traffic and Periods of Quiet in Pacific Palisades at Each of Six Measurement Locations.

CENTILE	MEASUREMENT LOCATIONS											
	1		2		3		4		5		6	
	PEAK	QUIET	PEAK	QUIET	PEAK	QUIET	PEAK	QUIET	PEAK	QUIET	PEAK	QUIET
95th	39.5	39.5	37.5	40.0	40.5	38.0	38.5	42.0	43.0	40.5	42.0	42.5
75th	44.5	44.5	42.5	43.0	41.5	41.0	42.5	45.5	45.5	43.0	48.0	45.5
50th	48.0	47.0	46.0	47.0	43.5	42.0	47.5	51.0	48.0	44.5	54.0	49.0
25th	54.5	53.0	52.0	53.5	47.5	46.5	54.5	58.0	53.5	48.0	60.0	53.0
05th	67.5	65.0	62.0	65.0	62.0	62.5	62.0	70.0	62.0	59.5	70.0	62.5

IDENTIFICATION AND RECRUITMENT OF TEST SUBJECTS

AIRPORT NEIGHBORHOOD

The initial effort in obtaining airport residents for the project was to attempt to identify the precise number of individuals living in the "island" area and determine their approximate length of residence. Investigation of the Los Angeles County Assessor's records showed numerous property owners who did not live in the area but rented the houses in Playa del Rey to others. Census records were not used since the 1970 data tapes had not been prepared at the time this work was initiated.

The method decided upon for contacting people in the area involved use of a telephone street address directory giving street addresses, names and telephone numbers. From this reference directory it was possible to send out an introductory letter in the mail to each address describing the nature of the project, advising that it involved a questionnaire, a medical check of the ear and a hearing test, and soliciting the participation of all residents. This initial mail contact was followed by a telephone call to each family listed in the directory. These telephone contacts were made by a long time resident of the area retained by Environmental Acoustics on this project. This individual was engaged for this work in an added attempt to foster confidence in the objectivity of the investigation and assure the residents that it did not represent an attempt to obtain information detrimental to their interests.

The initial telephone contact was employed as a preliminary screening procedure. During this initial conversation, a determination was made as to the number of individuals in the household meeting the general requirements for inclusion in the survey testing. These criteria included residency in excess of one year, absence of known ear pathology, age above 16 years (this was later changed to 10 years) and no unusual occupational noise exposure. People meeting these requirements were encouraged to participate in the survey and scheduled for testing.

The process of recruiting participants in the tests proved to be the most difficult aspect of this project. Attempting to deal with a substantial number of people on an individual basis introduces significantly more problems than hearing testing with organized groups such as in industrial or military organizations where there is some control over scheduling. Participation in the program was on a voluntary basis with a small incentive fee of $3.00 per test paid to each individual. A further incentive of providing the individuals with results of their hearing tests and medical check was also included.

Approximately 51% of the individual households were represented by the Playa del Rey residents taking part in the survey. Telephone contact was made with the occupants of 292 homes in this neighborhood, and individual addresses identified with the participants totaled 148 in the final tabulation. Those addresses were distributed evenly across the "island" area.

CONTROL NEIGHBORHOOD

The approach used in contacting and gaining the participation of Pacific Palisades residents in this survey was similar to that described above for Playa del Rey. Recruitment in this control area began after more than half of the airport residents had been tested, and an attempt was made to select persons here who, as a group, would match the composition of the Playa del Rey participants in terms of age, sex, and length of residency. Success in this matching effort was only partly successful (see Table VI). Pacific Palisades participants were drawn from about 52% of the households contacted by phone, the total number of home contacts being approximately 320.

PHASES OF HEARING SURVEY

All subjects in both study groups was to receive a three phase examination including otoscopic examination, questionnaire and audiometric evaluation. The purpose and extent of each test phase is described in this section.

OTOSCOPIC EXAMINATIONS

These were performed by a team of three physicians. The purpose of this examination was to detect any abnormality that might reasonably be expected to cause functional hearing losses not related to noise exposure. Examination was by otoscopic inspection of each ear. Disposable specula were used to insure that no communicable disorders would be transmitted from one subject to another. Additionally, the physicians questioned each subject concerning any history of ear disorders or other factors that might affect hearing levels. This information supplemented the questionnaire items relating to medical histories. Search for the following abnormalities was emphasized during the medical check.

(1) Retraction of the tympanic membrane

(2) Myringitis

(3) Chalk deposits

(4) Evidence of rupture of the tympanic membrane

(5) Aerotitis Media

(6) Secretory Otitis Media

(7) Hemotympanum

(8) Serous Otitis Media and Adenoids

(9) Tympanosclerosis

(10) Otosclerosis

Evidence for any of the above disorders was followed up by questioning the subject relative to symptomatic evidence. The physician judged whether or not the patient suffered from any otologic disorder. This information was duly recorded and utilized in screening subjects for inclusion in the subsequent statistical analyses. Screening criteria utilized in determining subject data to be included in analyses are described in a subsequent section of this report.

QUESTIONNAIRE

Each subject was additionally required to fill out a questionnaire containing items related to previous noise exposure and medical history. For most subjects, the questionnaire was completed in the presence of the testing personnel. In some cases, however, subjects took the questionnaire form to their home for reference and completion. They either returned the completed forms by mail or at the time of the audiometric test. Each questionnaire was then examined closely by the experimenters and any omissions or ambiguities resolved by telephone or personal visit to the subject. A questionnaire form is appended to this report for reference. Information from the questionnaires was numerically coded for subsequent machine analysis and use in screening individual subject factors of significance to this hearing evaluation. The scoring and coding rules are illustrated in the Appendix.

AUDIOMETRIC EVALUATION

Following (in some cases preceding) completion of the questionnaire, subjects were given an air conduction hearing test with discrete frequencies fixed at 500, 1000, 2000, 3000, 4000 and 6000 Hz. Five automatic audiometers were utilized during the test program (four at any given time). These units were calibrated to 1969 ANSI reference levels (23). As many as 4 subjects were tested at one time. When multiple tests were conducted simultaneously, each audiometer unit was operating independently. This required continuous monitoring of the electronic and mechanical operation of the unit by the technical personnel conducting the tests in order to rectify any malfunction with a minimum loss of time. Audiograms were recorded on standard forms for the particular machine used and hand scored for subsequent analysis. A sample audiogram is shown in Figure 7.

AUDIOMETRIC RETEST

Approximately one-half the subjects in the Playa del Rey group and one-third of those in the Pacific Palisades sample were recalled for audiometric retest. The purpose of this activity was primarily to provide a check of the reproducibility of the hearing threshold data obtained for the two groups. Time elapsed between test and retest sessions was variable, but in most cases exceeded two months.

ASPECTS OF SCHEDULING AND PROCEDURE

Each subject was advised at the outset that the results of the test he was to receive were only his individual hearing data and not collective values for the test area. This was done to preclude any immediate attempts to utilize the data in the continuing litigation associated with residences adversely affected by aircraft noise. Release of any collective test data was acknowledged to be the responsibility of the contracting agency. While many of the residents were quite cooperative, the matter of scheduling a compatible test time proved to be a difficult task. The most efficient test procedure for this type activity involves testing multiple individuals on a consistent rigorous schedule, e.g. a group of four each 10 or 15 minutes. The consistent problem in this

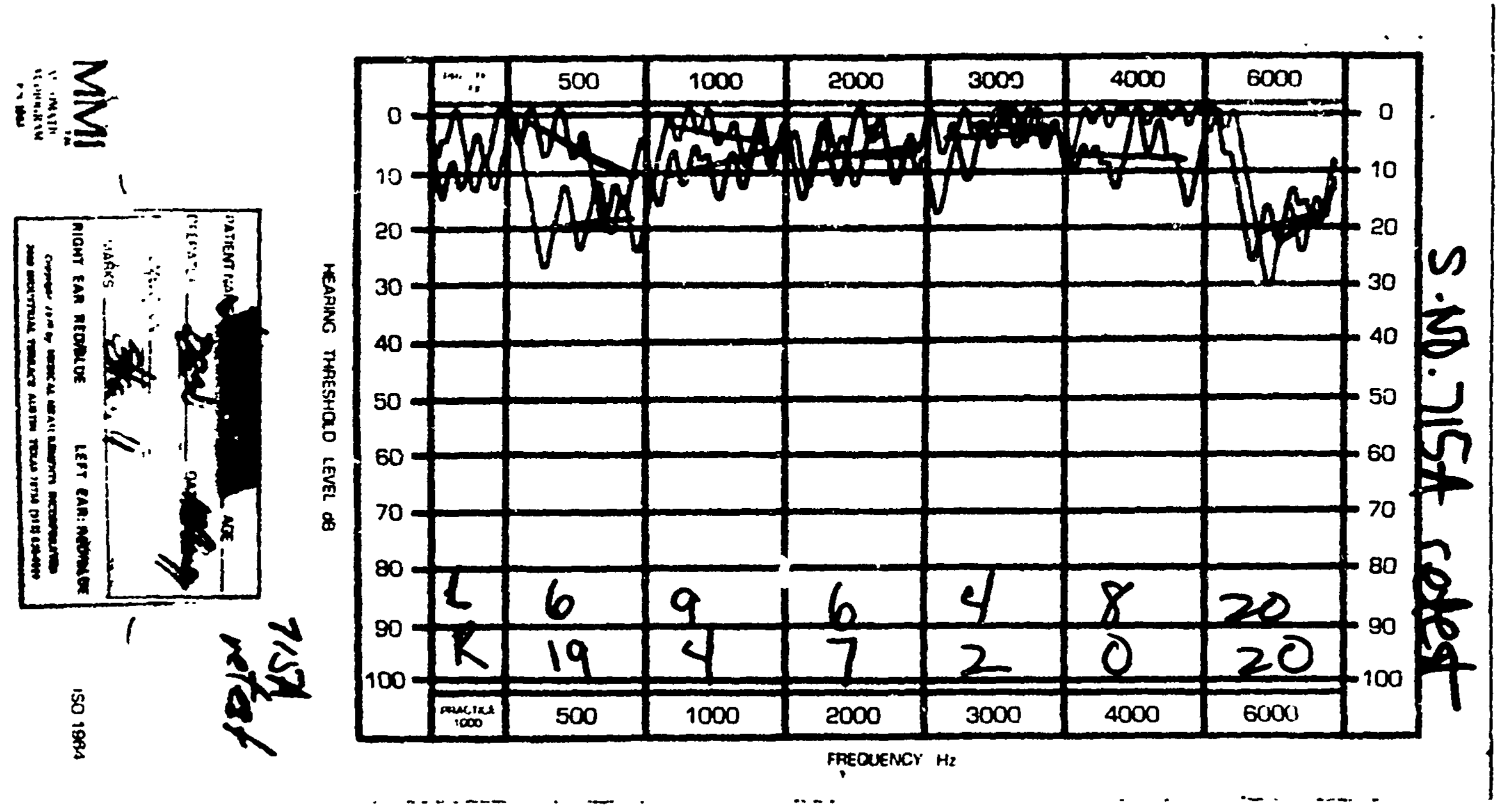


Figure 7. Sample Audiogram Form Used in the Study.

project was one of individuals failing to appear at a scheduled time or in many cases failing to appear at all. In the latter instance this involved rescheduling at a later date.

The initial sequence of testing consisted of administering the questionnaire and medical check and scheduling a hearing test for a later date. This resulted in numerous missed appointments and some loss of questionnaire data when subjects deferred completing certain of the items until factors such as house construction or dates of length of residency were checked before including them in the questionnaire.

After determining that most test subjects required one or more rescheduled appointments, a different approach was adopted. The medical check was conducted with large groups (20 or more) and questionnaires and hearing tests were then carried out with each individual in a separate session.

HEARING TEST EQUIPMENT AND METHODS

MOBILE UNIT AND AUDIOMETRIC EQUIPMENT

Since this program was dependent primarily on accurate and repeatable measurements of hearing thresholds for the individuals tested, it was necessary to assemble instrumentation which could be readily calibrated and would prove reliable over an extended time period under a variety of testing conditions.

It was not possible to plan to conduct hearing threshold testing in the Playa del Rey area because of the frequent interruption from aircraft noise during takeoff operations. These noise levels were sufficiently high to preclude any attempts at isolating a room for hearing threshold measurement in the immediate area. Any other methods such as interrupting the hearing testing during a fly-over and then resuming testing were rejected as being unworkable because of the frequency and duration of the interruptions as well as the potential for introducing an additional variable element in the hearing threshold measurement process.

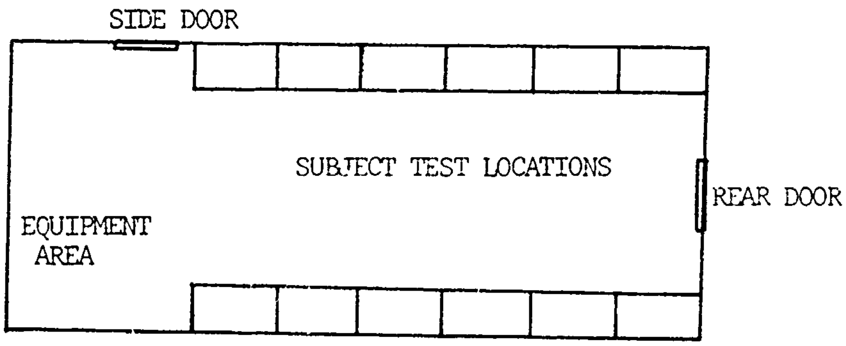
In an attempt to maintain the greatest consistency in the test equipment and procedures, a mobile hearing test unit was obtained from the Auditest Company of Santa Monica, California. This unit was leased for the test program and a plan was developed to utilize this facility in both the Playa del Rey and Pacific Palisades areas.

The mobile test unit consists of a room module made up of 18 lb/ft^2 sound attenuating panels with gasketed doors opening into the room. This assembly is mounted on a heavy duty truck frame. Connections on the exterior of the assembly provide for an external power source. The unit includes an air conditioning system in addition to the basic exhaust fan. Because of the location of the test areas close to the ocean, the air conditioning system was not used during any of the testing. This eliminated consideration of any increases in the interior noise levels in the unit due to the operation of the air conditioning system. A photograph of the Auditest Unit and the floor plan of the interior of the unit are shown in Figure 8.

Audiometric equipment used with the Auditest Unit consisted of four Medical Measurements, Inc., (MMI) Model 1000 automatic recording audiometers, with a fifth unit for back-up. These units included the test frequencies 500, 1000, 2000, 3000, 4000, and 6000 Hz. These five units were located as shown in Figure 9 with patch connectors led through conduits to the individual listening stations. The earphones (TDH-39 receivers) were inserted in MX 41/AR cushions with the entire assembly mounted in Otocups manufactured by Tracor, Inc. The Otocups were utilized to provide additional sound isolation during testing. Attenuation properties expressed in dB per octave band are shown for both the van wall structures and the Otocup earpieces in Table IV. Also indicated

EXTERIOR VIEW

INTERIOR VIEW



(Drawing not to scale.)

Figure 8. Exterior and interior views and floor plan of the audiometric test van used in the study.

TABLE IV Attenuation Values in dB Afforded by the Test Van and Otocups and Maximum Allowable Background Levels to Insure Non-Masking of Hearing Levels re ANSI '0'.

OCTAVE BAND CENTER FREQUENCIES

	250	500	1000	2000
Mobile Van with 18 lb/ft^2 wall construction	41	51	58	63
Circumaural Otocup + MX41/AR cushion (MAX)	17	23	30	40
Range of Outdoor Sound Levels (in dB re 0.0002 microbar)	55-62	50-58	52-56	48-55
Range of Indoor Sound Levels (in dB re 0.0002 microbar)	32-47	20-42	15-22	15-20
Maximum Allowable Sound Levels in Test Room When Wearing Otocups to Attain Non-masked Hearing Levels re ANSI '0' reference.[a]	37	43	48	49

[a]Represents prescribed maximum allowable background levels for audiometer rooms (S3.1-1960, American Standards Association, N.Y.) adjusted to reflect increased attenuation of the Otocups relative to the standard earpiece and differences in ANSI 1969 and ASA 1951 reference threshold levels.

are ranges of octave band sound levels for noise measured in the van's interior as contrasted with those found concurrently for ambient conditions outside. These measurements were taken as performance checks on the van. The interior sound levels, particularly for the higher octave bands centered at 1000 and 2000 Hz, do not reflect completely the structural attenuation of the van owing to interior generated noise of unknown origin becoming predominant. Noted in Table IV are estimated maximum permissible octave band sound levels for a test area when Otocups are used in an attempt to attain non-masked threshold readings as low as the 1969 ANSI reference for '0' hearing level at test frequencies 500 Hz and above. Sound levels measured inside the Auditest van during the audiometric testing did not exceed the limit for the 500 Hz centered octave by more than 5dB and were well below the limits for the higher octave band frequencies. This permitted non-masked hearing level readings for the test frequencies of interest within 5dB of the 1969 ANSI '0' reference or better.

The mobile van was located several miles from the Playa del Rey "island" area to minimize possible test interference from the high level aircraft fly-over sound in the course of surveying this neighborhood group. At this location there were some aircraft sounds found audible inside the mobile unit which originated from low-flying military aircraft operating from a nearby airfield. These 10-15 second overflights never exceeded two in a given day, and when they were experienced, the hearing testing was interrupted and restarted after the event. The van was situated on a residential street in the Pacific Palisades neighborhood from which the control resident group was drawn.

CALIBRATION

Calibrations of the hearing measurement system were conducted at frequent intervals during the test program. Both biological calibrations and artificial ear calibrations were performed. For each test session one of the examiners would conduct hearing threshold measurements for both of his ears on each of the audiometers. These data were compared with previous tests for the same individual under the same conditions as a check for consistency. These comparisons served to confirm consistent performance from the audiometer or, in some instances, to identify a defective unit.

Calibrations carried out with a B & K Type 4152 Artificial Ear with a 6cc coupling cavity are shown in Table V in terms of corrections to be applied to measured hearing threshold levels for agreement with 1969 ANSI standard sound pressure levels for audiometric zero levels. These corrections were included in the initial phase of the analysis program so that all data could be treated similarly following incorporation of these corrections.

TABLE V Correction Factors in Decibels Applied to Hearing Level Data to Conform to 1969 ANSI Reference Sound Pressure Levels at each of the Audiometric Test Stations Used in the Study.

STA.	EAR	TEST FREQUENCY (HZ)					
		500	1000	2000	3000	4000	6000
1	L	-4	-5	-3	-6	-4	-10
	R	0	-1	-4	-7	-8	-13
2	L	-8	-5	-5	-4	-6	-8
	R	-6	-3	-4	-7	-4	-12
3	L	-4	-2	-3	-2	-4	-7
	R	-3	-1	-3	-5	-5	-9
5	L	-2	+6	+1	-3	-2	-12
	R	+2	+9	+2	-1	0	-10
6	L	0	+3	+3	-2	+1	-13
	R	0	+3	+3	-1	0	-11

SCREENING CRITERIA

As noted, subjects were screened for inclusion in the major analyses with respect to a number of criteria relating to medical history, noise exposure history, etc. This was done because of the relatively small number of total subjects tested so that non-noise induced hearing losses or those hearing losses reasonably attributed to occupational or other non-aircraft environmental noise exposures would not bias the subsequent analysis. These criteria are listed below. In addition, malingering and inconsistency were the basis for exclusion in some cases. All audiometers were equipped with a malingering test designed to detect persons who could not perform the task or those who actively tried to feign their test results. While there were only a few subjects in the latter category, there were a significant number of subjects who experienced difficulty with the test procedure with erratic results. Subjects judged to fall in these two categories were not included in any further analyses. The nominal screening criteria were:

1. Residential Background: Failure for a resident in the airport community to rate his present living area as the noisiest he has lived in would question any hearing loss in the audiogram as being due to aircraft noise exposure. It might be due to a previous community noise experience acknowledged by the resident to be even more severe in nature.

2. Occupational Noise Exposure: Exclusion based on two or more years of exposure to a noisy work environment in which one had to shout in order to be heard by fellow workers even at close distances. Regular use of ear protection in such situations would allow for inclusion.

3. Military Service: Exclusion here was dictated by; a) Weekly exposures to weapon-type noise for one or more years; b) One or more years of actual combat (front-line) experience; c) Routine daily exposure to noise of vehicles or mechanized equipment (aircraft or armored vehicles, field generators for missile systems). Those who indicated that their only weapon noise exposure was in basic training and/or who routinely wore ear protection when firing or operating noisy equipment were not eliminated.

4. Non-Occupational Noise Exposure: Shooters exposed to weapon noise for 1000 rounds per year for one or more years and who wore no ear protection when firing were excluded. Participation in noisy off-job activities such as rock music playing, drag-racing, cycling, sport flying at least three times per week for one or more years were also eliminated.

5. Vehicle Noise Exposure: Persons who have ridden on motorcycles, streetcars, subways, airplanes at least three times per week for roundtrips of one or more hours and for three or more years were eliminated.

6. Abnormal Medical History: Exclusion if there was a history of severe head trauma, chronic ear infections, or evidence of hereditary deafness in family. Certain other conditions such as Meniere's disease, protracted use of mycin drugs and aspirin or history of ear surgery also were grounds for elimination. Persons having severe head colds at time of hearing testing were scheduled for testing at a different time.

7. Otologic Irregularities: Total closure of the ear canal by cerumen, excessive scar tissue on tympanic membrane, perforated tympanic membrane, otitis media or otosclerosis served as a basis for excluding hearing data. The team of physicians made judgments as to exclusion in questionable cases.

8. Audiometric Irregularities: Exclusions here were based on, a) Audiograms revealing as much or greater low frequency hearing loss than high frequency loss (suspected conductive disorder) in one or both ears; b) Hearing loss in one ear 40 dB greater than the other ear at two or more test frequencies.

A total of 312 persons living in Playa del Rey entered into all phases of the testing, and 377 residents of the Pacific Palisades neighborhood did likewise.[7] Of these totals, 43 persons in Playa del Rey and 67 persons in the Pacific Palisades were disqualified from all data analyses largely because of active malingering or inability to provide an interpretable, reasonably stable audiometric record. The remaining number of participants, 269 from Playa del Rey and 310 from the Pacific Palisades, thus provided the core data for this survey. Table VI shows the composition of these two residential groups by age, sex, and length of residency in the two neighborhoods in question. A fair match of these two groups is indicated for the different variables, the greatest difference appearing in the youngest age group where there are more participants from the Pacific Palisades.

Application of the abovementioned screening criteria to the otologic and questionnaire data and to the audiogram traces obtained for these subjects revealed a number of persons whose hearing could have been affected by factors other than the environmental noise under study. An inventory of such cases appears in Table VII. Hearing data from these individuals were excluded from those analyses attempting to isolate as much as possible any hearing level changes attributable to aircraft noise exposure.

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7. These numbers do not include some residents who started in the test program but did not complete all of the required phases.

TABLE VI Composition of Playa del Rey Test and Pacific Palisades Control Groups of Participating Residents Constituting the Core Hearing Data By Age, Sex and Average Length of Residency.

AGE GROUP (YEARS)	10-17		18-24		25-34		35-44		45-54		55-64		65-74		74 & UP*	
SEX	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
TOTAL NUMBER OF SUBJECTS IN PLAYA DEL REY	24	19	23	15	12	11	17	20	30	44	19	16	10	6	1	1
TOTAL NUMBER OF SUBJECTS IN PACIFIC PALISADES	39	40	31	22	8	21	15	28	33	33	15	13	4	6	0	1
AVERAGE LENGTH OF RESIDENCY IN YEARS (PDR)	11.4	9.11	11.6	14.1	8.6	9.0	8.7	10.1	14.9	13.8	16.3	19.1	17.7	16.3	11.0	11.0
AVERAGE LENGTH OF RESIDENCY IN YEARS (PP)	9.4	11.2	12.8	14.1	6.0	4.6	8.6	10.5	15.9	16.1	21.3	19.2	12.6	14.7	-	17.0

*Small number of subjects in this age group prevented any separate statistical treatment of their data.

TABLE VII Number of Persons Failing Screening Criteria in Playa del Rey (PDR) and Pacific Palisades (PP) Groups.

Criterion Reason for Exclusion	Number Excluded in PDR	Number Excluded in PP.	Totals
1. Other residential areas judged noisier than current community	0	—[a]	0
2. Undue Occupational Noise Exposure	6	17	23
3. Undue Non-Occupational Noise Exposure	39	46	85
4. Abnormal Medical History	18	25	43
5. Observed Otologic Irregularities	7	12	19
6. Audiometric Irregularities-Inferred Etiology (Suspected conductive loss)	28	18	46
Totals	98	118	216

[a]This was not an exclusion criterion for the Pacific Palisades Residents.

EVALUATION OF HEARING LEVEL DATA

RELIABILITY OF AUDIOGRAMS

As mentioned earlier in the methodology, approximately one-half of the participants from Playa del Rey and one-third of those from the Pacific Palisades neighborhood were given a second audiometric test sometime after the first one. These test-retest determinations were intended to ascertain the reliability of the hearing level data. Tables VIII-IX summarize the results, indicating that differences between mean hearing levels for the original and repeat tests are quite small in both subject groups. Most mean differences were less than 2 dB and none exceeded 3.5 dB. Standard deviation magnitudes independently computed for the test and retest findings, showed close similarity also. In addition, Pearson product-moment correlation coefficients were computed at each audiometric frequency and for each ear to establish the degree of correspondence between the test and retest hearing levels observed for both neighborhood groups (24). Greater coefficients are noted at the higher frequencies (2000 Hz and above), reflecting more consistency in these threshold readings relative to those obtained at the lower frequencies. Reasons for this result are only conjectural. All such correlation coefficients were significant and, together with the small differences in mean test-retest values, suggest a good degree of reliability in the audiograms obtained in the survey.

HEARING DATA FOR TOTAL AND SCREENED SUBJECT GROUPS

Hearing levels and standard deviations were initially computed for all subjects in each test neighborhood by age, sex and right and left ears. These data are shown in Tables X-XII. These data are subsequently to be referred to as "total" or "unscreened" group measures as distinguished from similar values computed for only those subjects who survived the exclusion criteria outlined above. The latter are termed "screened" group measures which are presented in Tables XIV-XVIII. Primary emphasis was placed on the examination of the screened group data since it provided the least contaminated picture of hearing level differences, if any, between residents in the airport and control communities.

With few exceptions, total versus screened group means for the Playa del Rey and Pacific Palisades samples show the screened values to be lower, reflecting better hearing irrespective of ears, sex, and test frequency (compare Tables X and XI with XIV and XV). Inspection of the standard deviations for the total group and screened group data also show the latter to be less variable (compare entries in Tables XII and XIII with those in Tables XVI and XVII. Hence, the net effect of the screening process was to remove deviant hearing values, probably of non-noise origin (e.g., otologic disorders) or if due to noise, apart from the neighborhood exposures in question. Centile distributions of the unscreened and screened data, to be discussed later (Tables XXI-XXIV) are even more revealing of this result.

TABLE VIII Summary Evaluation of Test-Retest Hearing Data for Playa Del Rey Group.

TEST FREQUENCIES (Hz)

			500	1000	2000	3000	4000	6000
Mean Hearing Levels in Decibels re ANSI 1969	Right Ear	Test	17.61	14.65	10.24	12.83	12.81	19.71
		Retest	17.85	14.51	9.69	12.80	13.17	17.32
	Left ear	Test	17.73	11.36	9.42	14.22	13.68	19.42
		Retest	21.16	13.35	9.54	13.69	14.09	17.55
Standard Deviations in Decibels	Right Ear	Test	10.60	10.68	11.70	13.83	16.57	19.29
		Retest	10.69	10.89	11.24	14.46	16.03	19.44
	Left Ear	Test	9.20	11.30	13.28	15.01	16.88	18.05
		Retest	10.22	10.75	12.02	14.23	15.41	17.12
Test-Retest Correlation Coefficient[a]	Right ear	r=	.56	.60	.73	.77	.82	.84
	Left ear	r=	.55	.65	.84	.85	.81	.81

[a]All coefficients were statistically significant ($P < .01$)

TABLE IX Summary Evaluation of Test-Retest Data for Pacific Palisades Group.

TEST FREQUENCIES (Hz)

			500	1000	2000	3000	4000	6000
Mean Hearing Levels in Decibels re ANSI 1969	Right Ear	Test	17.91	14.32	9.47	13.78	15.99	18.76
		Retest	19.60	13.66	8.21	12.46	15.13	17.19
	Left Ear	Test	17.66	11.85	8.37	13.25	16.33	18.40
		Retest	17.01	9.98	7.80	12.59	16.03	18.57
Standard Deviations in Decibels	Right Ear	Test	8.94	9.97	10.20	14.44	17.67	19.43
		Retest	8.83	9.07	9.80	13.95	16.42	20.13
	Left Ear	Test	7.53	8.75	8.62	13.73	16.74	17.55
		Retest	6.86	7.62	8.20	14.79	17.00	18.49
Test-Retest Correlation Coefficient[a]	Right ear	r=	.50	.54	.79	.82	.88	.85
	Left ear	r=	.45	.43	.79	.86	.90	.82

[a]A 11 coefficients were statistically significant ($P < .01$)

TABLE X Mean Hearing Levels in Decibels re 1969 ANSI Standard for Unscreened Males in Playa Del Rey and Pacific Palisades Communities by Frequency and Age Group.

AGE	AREA	N	LEFT EAR						RIGHT EAR					
			TEST FREQUENCY (HZ)						TEST FREQUENCY (HZ)					
			500	1000	2000	3000	4000	6000	500	1000	2000	3000	4000	6000
10-17	PDR	24	15.3	6.1	0.5	4.8	4.2	9.2	12.4	9.5	3.6	4.8	3.9	9.6
	PP	39	16.1	9.1	4.7	5.5	6.0	5.7	17.7	13.3	6.3	5.8	4.7	9.2
18-24	PDR	23	16.2	11.8	8.0	9.6	9.5	21.2	17.9	14.0	6.2	6.9	8.9	16.1
	PP	31	17.3	9.1	3.6	4.8	5.1	6.1	16.2	11.1	4.6	3.9	2.4	9.1
25-34	PDR	12	17.1	8.8	5.2	9.2	11.5	16.1	15.6	12.9	5.5	8.2	12.2	14.8
	PP	8	18.6	10.4	2.0	8.4	11.5	10.8	14.6	7.9	4.8	6.8	7.5	13.5
35-44	PDR	17	14.5	9.0	4.1	17.9	21.9	28.8	16.9	13.7	6.4	16.1	19.2	37.3
	PP	15	15.9	7.2	7.5	16.4	21.1	22.3	13.6	8.7	4.3	13.0	19.3	20.7
45-54	PDR	30	16.5	12.6	14.5	27.1	33.0	36.7	16.0	13.7	15.1	26.9	33.1	39.8
	PP	33	22.4	15.5	14.9	30.9	32.6	33.2	17.9	18.0	18.1	30.6	33.9	37.6
55-64	PDR	19	16.0	10.6	15.7	29.3	33.0	38.5	16.7	15.7	17.0	29.2	36.7	41.4
	PP	15	19.1	11.7	12.8	29.9	38.6	36.9	18.1	12.4	10.3	21.5	30.3	28.8
65-74	PDR	10	29.1	27.7	39.3	54.0	52.6	61.7	28.6	27.5	41.6	54.4	56.0	65.6
	PP	4	15.5	10.0	11.0	26.8	40.0	37.8	10.5	10.2	8.0	17.2	31.2	43.8

TABLE XI Mean Hearing Levels in Decibels re 1969 ANSI Standard for Unscreened Females in Playa Del Rey and Pacific Palisades Communities by Frequency and Age Group.

AGE	AREA	N	LEFT EAR TEST FREQUENCY (HZ)						RIGHT EAR TEST FREQUENCY (HZ)					
			500	1000	2000	3000	4000	6000	500	1000	2000	3000	4000	6000
10-17	PDR	19	13.0	7.9	5.3	6.5	3.3	6.5	18.5	14.5	7.2	5.3	2.5	5.6
	PP	40	15.2	9.5	4.2	7.6	4.0	6.4	15.5	11.8	7.0	6.7	5.6	5.2
18-24	PDR	15	13.3	6.1	4.0	3.3	2.3	4.3	11.3	10.9	7.1	4.9	3.3	3.9
	PP	22	14.4	6.3	3.0	3.4	3.1	5.9	16.3	9.8	3.0	5.3	1.8	5.0
25-34	PDR	11	14.3	8.3	5.2	11.6	11.8	20.7	13.6	12.4	7.4	12.6	8.4	20.8
	PP	21	19.0	11.4	7.9	8.1	9.0	9.1	18.5	13.6	6.6	8.2	8.9	12.0
35-44	PDR	20	16.6	12.1	7.0	10.1	8.9	14.6	18.4	16.8	10.0	10.0	7.8	13.8
	PP	28	18.0	9.2	5.8	7.0	[illegible].9	9.0	17.8	11.6	6.3	7.4	7.5	8.5
45-54	PDR	44	20.0	14.0	11.1	17.7	14.8	22.9	20.2	17.6	13.8	16.0	13.4	22.1
	PP	33	20.6	13.8	9.4	14.6	12.4	20.0	20.5	14.8	11.2	13.1	12.8	15.6
55-64	PDR	16	28.2	22.7	23.8	27.8	25.4	31.9	28.4	30.9	27.2	26.9	26.9	29.8
	PP	13	18.3	14.2	9.8	22.2	25.2	33.6	20.2	16.6	12.6	15.6	26.5	25.1
65-74	PDR	6	27.0	22.0	24.0	34.7	32.2	37.5	23.7	23.0	23.8	27.8	38.7	35.7
	PP	6	31.3	28.2	24.5	29.0	35.5	40.0	25.0	23.2	16.0	24.5	27.2	32.5

TABLE XII Standard Deviations in Decibels for Hearing Levels of Unscreened Males in Playa Del Rey and Pacific Palisades Communities by Frequency and Age Group.

AGE	AREA	N	LEFT EAR						RIGHT EAR					
			TEST FREQUENCY (HZ)						TEST FREQUENCY (HZ)					
			500	1000	2000	3000	4000	6000	500	1000	2000	3000	4000	6000
10-17	PDR	21	5.6	7.4	5.0	6.5	6.1	11.5	7.1	7.5	5.8	7.1	7.6	9.0
	PP	29	7.0	8.3	5.6	5.4	5.9	7.8	7.3	7.7	6.5	6.9	6.0	8.8
18-24	PDR	16	14.2	6.2	2.2	11.2	10.2	13.5	7.3	6.2	3.8	7.0	7.3	11.4
	PP	18	6.2	7.0	5.2	6.4	6.4	8.7	7.8	6.7	4.9	5.3	5.8	10.1
25-34	PDR	10	6.9	6.9	5.3	7.6	9.6	8.6	6.8	7.1	5.5	7.8	9.2	9.8
	PP	3	8.4	6.1	5.0	6.5	10.1	9.6	11.5	4.6	4.0	6.8	23.1	10.7
35-44	PDR	5	8.1	7.3	5.0	11.7	12.2	9.4	8.4	7.6	5.0	8.3	16.8	13.4
	PP	9	6.6	5.5	10.6	9.3	9.3	11.4	7.1	7.2	4.4	10.4	8.0	8.1
45-54	PDR	10	5.7	6.2	6.4	16.0	15.1	11.3	7.8	6.1	5.6	12.5	18.3	24.7
	PP	7	7.8	10.4	8.2	16.6	18.1	11.2	7.5	9.0	8.1	15.0	15.3	17.1
55-64	PDR	13	6.7	9.1	7.0	10.5	17.1	12.7	7.6	2.9	7.3	18.1	20.0	17.4
	PP	8	6.5	6.4	6.7	7.7	17.8	15.4	7.8	9.8	8.3	14.8	18.9	18.5
65-74	PDR	7	4.4	7.8	2.6	16.5	16.8	12.9	7.6	5.7	2.6	18.3	13.5	14.8
	PP	3	10.2	9.8	11.1	4.9	5.8	6.6	11.1	11.4	13.3	12.2	6.7	7.6

TABLE XIII Standard Deviations in Decibels for Hearing Levels of Unscreened Females in Playa Del Rey and Pacific Palisades Communities by Frequency and Age Group.

AGE	AREA	N	LEFT EAR TEST FREQUENCY (HZ)						RIGHT EAR TEST FREQUENCY (HZ)					
			500	1000	2000	3000	4000	6000	500	1000	2000	3000	4000	6000
10-17	PDR	13	6.0	7.6	5.7	4.9	4.5	6.8	9.0	8.6	5.2	7.3	4.3	7.6
	PP	30	5.6	7.4	5.0	6.9	7.0	7.2	7.1	7.5	5.8	6.8	7.4	9.2
18-24	PDR	13	6.9	7.4	5.2	5.7	6.9	8.7	8.2	8.2	5.1	6.2	5.5	8.7
	PP	20	5.2	5.1	4.0	5.9	5.1	7.6	7.3	6.2	3.8	7.8	8.0	9.1
25-34	PDR	7	8.4	7.0	6.5	6.5	8.6	11.2	4.2	6.7	6.0	6.2	5.4	5.1
	PP	16	6.9	6.9	5.3	9.9	7.5	8.5	6.8	7.1	5.5	7.1	9.2	10.4
35-44	PDR	16	9.9	8.4	7.0	10.2	13.9	15.6	8.2	6.0	6.7	7.1	11.1	13.8
	PP	22	8.1	7.3	5.0	6.3	9.1	9.4	8.4	7.6	5.0	6.3	9.4	8.9
45-54	PDR	25	6.5	7.5	10.2	11.3	14.0	13.7	8.8	8.8	8.4	14.1	11.5	11.9
	PP	18	5.7	6.2	6.4	6.3	9.8	9.3	7.8	6.1	5.6	8.8	11.5	11.1
55-64	PDR	7	6.7	9.3	16.5	12.8	11.4	14.4	7.7	9.8	12.4	10.6	12.2	18.8
	PP	7	6.7	9.1	7.0	4.9	8.8	11.2	7.6	2.9	7.3	5.0	10.8	14.5
65-74	PDR	5	9.2	5.4	14.5	16.3	13.9	8.8	6.9	9.1	13.3	13.2	14.3	10.9
	PP	3	4.4	7.8	2.6	4.0	10.4	9.1	7.6	5.7	2.6	3.2	7.4	13.0

TABLE XIV Mean Hearing Levels in Decibels re 1969 ANSI Standard for Screened Males in Playa Del Rey and Pacific Palisades Communities by Frequency and Age Group.

AGE	AREA	N	LEFT EAR TEST FREQUENCY (HZ) 500	1000	2000	3000	4000	6000	RIGHT EAR TEST FREQUENCY (HZ) 500	1000	2000	3000	4000	6000
10-17	PDR	21	15.1	5.7	-0.1	4.0	2.1	8.6	11.9	9.1	2.9	5.5	2.6	9.0
	PP	29	14.8	7.6	8.4	4.2	3.6	[illegible]1.9	16.2	11.4	[illegible].7	3.8	2.1	15.6
18-24	PDR	16	12.8	7.1	4.1	7.3	5.9	12.3	15.2	10.8	3.8	4.2	1.9	10.1
	PP	18	17.8	9.2	4.0	4.3	4.8	6.1	16.4	11.2	3.6	4.7	3.3	6.3
25-34	PDR	10	15.5	8.0	6.0	9.5	6.7	10.4	15.3	11.9	6.1	8.4	7.6	11.5
	PP	3	15.7	8.0	5.0	6.7	10.7	12.7	18.0	6.0	7.7	6.7	12.[illegible]	14.7
35-44	PDR	5	13.6	7.0	-0.6	16.2	18.8	8.4	15.0	8.8	1.2	7.2	7.[illegible]	16.2
	PP	9	14.4	4.6	7.2	12.1	13.4	15.8	11.4	7.2	2.4	9.8	10.6	7.8
45-54	PDR	10	12.0	6.1	7.6	21.9	29.7	34.1	12.7	9.7	4.7	15.4	24.7	37.1
	PP	7	17.4	12.4	7.9	19.0	25.7	2[illegible]	1[illegible].0	11.3	8.3	14.5	16.7	17.1
55-64	PDR	13	12.7	8.5	14.3	26.1	28.4	36.4	[illegible]1.8	11.3	14.3	23.8	33.5	37.2
	PP	8	19.8	10.2	11.8	23.0	28.9	27.6	20.8	14.0	9.1	19.0	21.6	20.8
65-74	PDR	7	27.9	26.9	37.7	47.9	50.4	54.6	28.3	28.7	41.0	45.3	47.0	60.3
	PP	3	15.0	9.0	11.7	29.3	38.3	35.0	8.3	11.3	8.7	18.0	27.7	40.7

TABLE XV Mean Hearing Levels in Decibels re 1969 ANSI Standard for Screened Females in Playa Del Rey and Pacific Palisades Communities by Frequency and Age Group.

AGE	AREA	N	LEFT EAR TEST FREQUENCY (HZ)						RIGHT EAR TEST FREQUENCY (HZ)					
			500	1000	2000	3000	4000	6000	500	1000	2000	3000	4000	6000
10-17	PDR	13	11.2	4.6	2.5	5.1	0.5	4.4	14.1	9.9	2.1	1.3	-1.7	2.2
	PP	30	13.6	8.3	2.5	6.1	2.5	5.2	14.5	11.4	6.5	5.8	5.4	3.6
18-24	PDR	13	12.0	4.6	3.6	2.6	1.3	2.5	9.8	8.5	3.8	1.8	0.1	0.5
	PP	20	14.2	6.2	2.2	2.2	2.0	4.8	15.5	10.4	2.2	4.6	1.2	4.4
25-34	PDR	7	13.1	6.7	2.9	7.6	6.0	14.3	12.4	11.0	4.9	9.7	1.1	9.3
	PP	16	17.9	9.7	6.9	7.5	6.8	5.8	17.6	11.8	4.4	5.3	4.9	7.8
35-44	PDR	16	15.1	9.4	9.6	9.0	8.4	14.6	16.9	13.4	7.1	8.2	5.4	13.1
	PP	22	18.2	8.6	5.3	7.4	9.0	8.8	17.4	10.6	5.7	5.8	7.6	9.4
45-54	PDR	25	16.2	10.8	8.0	15.2	14.0	20.6	15.8	11.9	9.7	11.5	9.2	18.8
	PP	18	16.5	9.6	6.3	8.1	6.5	16.8	16.5	11.6	8.5	8.9	9.3	14.6
55-64	PDR	7	20.9	11.4	15.9	20.7	22.1	23.6	15.6	18.3	14.0	16.1	18.6	16.7
	PP	7	14.9	9.7	5.6	17.9	19.6	25.4	21.7	14.6	16.9	13.6	15.9	24.0
65-74	PDR	5	21.4	15.0	17.8	31.0	28.0	33.8	21.4	21.6	19.8	26.6	37.4	35.8
	PP	3	23.0	17.0	14.0	18.7	27.0	28.3	27.3	24.7	16.0	17.7	22.7	33.0

TABLE XVI Standard Deviations in Decibels for Hearing Levels of Screened Males in Playa Del Rey and Pacific Palisades Communities by Frequency and Age Group.

AGE	AREA	N	RIGHT EAR TEST FREQUENCY (HZ)						LEFT EAR TEST FREQUENCY (HZ)					
			500	1000	2000	3000	4000	6000	500	1000	2000	3000	4000	6000
10-17	PDR	21	6.55	5.59	6.89	7.08	7.65	9.00	6.95	7.70	4.50	6.54	6.07	11.51
	PP	29	7.34	7.73	6.47	6.89	5.99	8.82	6.95	8.28	5.57	5.44	5.88	7.78
18-24	PDR	16	6.22	6.94	6.98	7.00	7.28	11.35	6.77	7.24	7.52	11.16	10.19.	13.53
	PP	18	7.85	6.73	4.88	5.27	5.80	10.08	6.17	6.96	5.18	6.43	6.37	8.70
25-34	PDR	10	6.63	5.02	6.06	7.79	9.18	9.81	5.80	3.74	7.27	7.58	9.55	8.62
	PP	3	11.53	4.58	4.04	6.81	23.07	10.69	8.39	6.08	5.00	6.51	10.07	9.61
35-44	PDR	5	8.89	5.97	5.17	8.28	16.81	13.35	6.27	6.32	3.85	11.67	12.17	9.40
	PP	9	7.11	7.17	4.39	10.40	8.00	8.11	6.62	5.46	10.58	9.29	9.33	11.41
45-54	PDR	10	7.44	6.90	5.79	12.50	18.26	24.66	8.65	7.98	9.83	16.05	15.06	11.33
	PP	7	7.33	8.99	8.10	14.99	15.29	12.79	7.81	10.44	8.23	16.59	18.08	11.21
55-64	PDR	13	8.28	7.16	14.60	18.22	20.04	17.35	7.13	9.75	12.96	10.53	17.10	12.66
	PP	8	7.85	9.83	8.27	14.77	18.86	18.47	6.54	6.43	6.69	7.73	17.75	15.36
65-74	PDR	7	9.21	11.93	14.55	18.34	13.45	14.84	7.76	9.51	13.46	16.47	16.81	12.90
	PP	3	11.06	11.37	13.28	12.17	6.66	7.64	10.15	9.85	11.06	4.93	5.77	6.56

TABLE XVII Standard Deviations in Decibels for Hearing Levels of Screened Females in Playa Del Rey and Pacific Palisades Communities by Frequency and Age Group.

AGE	AREA	N	RIGHT EAR TEST FREQUENCY (HZ)						LEFT EAR TEST FREQUENCY (HZ)					
			500	1000	2000	3000	4000	6000	500	1000	2000	3000	4000	5000
10-17	PDR	13	8.98	8.61	5.25	7.33	4.33	7.59	5.98	7.64	5.67	4.94	4.48	6.75
	PP	30	7.06	7.48	5.78	6.79	7.41	9.19	5.62	7.42	5.05	6.89	6.95	7.15
18-24	PDR	13	8.22	8.25	5.08	6.23	5.51	8.74	6.93	7.40	5.20	5.69	6.88	8.72
	PP	20	7.29	6.20	3.82	7.80	8.00	9.09	5.17	5.09	3.99	5.90	5.12	7.58
25-34	PDR	7	4.24	6.66	5.98	6.24	5.37	5.12	8.41	7.02	6.54	3.71	1.14	9.29
	PP	16	6.78	7.08	5.49	7.10	9.22	10.41	6.88	6.86	5.28	9.87	7.51	8.47
35-44	PDR	16	6.21	6.05	6.72	7.07	11.14	13.82	9.94	8.43	6.97	10.15	13.94	15.62
	PP	22	8.36	7.60	4.99	6.34	9.45	8.89	8.13	7.27	4.99	6.28	9.12	9.38
45-54	PDR	25	8.75	8.85	8.37	14.09	11.49	11.94	6.53	7.48	10.24	11.30	14.05	13.69
	PP	18	7.82	6.09	5.61	8.79	11.52	11.10	5.67	6.20	6.35	6.34	9.78	9.32
55-64	PDR	7	7.72	9.76	12.41	10.65	12.18	18.85	6.67	9.27	16.54	12.76	11.42	14.36
	PP	7	7.59	2.94	7.27	4.96	10.78	14.50	6.74	9.07	7.00	4.88	8.77	11.15
65-74	PDR	5	6.88	9.07	13.33	13.18	14.28	10.89	9.21	5.43	14.52	16.31	13.89	8.79
	PP	3	7.57	5.69	2.65	3.21	7.37	13.00	4.36	7.81	2.65	4.04	10.44	9.07

COMPARISONS OF SCREENED HEARING DATA FOR AIRPORT AND CONTROL AREA RESIDENTS

This evaluation was guided by several working hypotheses. First, that if community aircraft noise exposure in Playa del Rey did in fact, cause hearing loss, the mean hearing levels of the residents should be elevated (poorer) relative to those observed for the control area residents not so exposed. Second, owing to this aircraft noise exposure, the airport neighborhood residents should also exhibit increased variance in their hearing levels as a result of individual differences in amount of aircraft noise actually received, susceptibility to noise-induced hearing loss, etc. Lastly, it was expected that these noise related changes in the hearing of the airport group would be frequency dependent. That is, these would be more likely to occur at the higher frequencies in the audiogram which are more vulnerable to noise damage.

Table XVIII shows differences in mean hearing levels between screened groups of Playa del Rey and Pacific Palisades residents by age, ear, sex, and test frequency. Close examination of these differences shows them to be equivocal for most age groups. The older age categories, more notably in the males, show the largest differences, which are in a direction suggesting more hearing loss in the airport neighborhood. This interpretation must be tempered, however, due to the few numbers of subjects in these older age groups (from 3 to 7 subjects) which can make the results unrepresentative. For most of the other age groups, differences in mean hearing levels between the test groups of residents at frequencies of 2000 Hz and below are slight and show no systematic variation for males or females. For test frequencies of 3000 Hz and above, however, somewhat greater differences appear. The direction of such differences is not always consistent. The two youngest groups of female subjects from Playa del Rey (10 to 17 years and 18 to 24 years) show as good or better hearing than their counterparts in Pacific Palisades. On the other hand, for middle age categories (above 24 and less than 64 years), most of the differences for the high frequencies show Playa del Rey hearing to be worse than that of the Pacific Palisades.

Bearing on the latter point, a Wilcoxen signed-rank test (24) was applied to the differences in Table XVIII to obtain a composite view of their direction relative to the question of hearing changes caused by the community aircraft noise. In these analyses, differences for ears and ages were individually ranked in magnitude within a low frequency cluster (500, 1000, and 2000 Hz) and a high frequency cluster (3000, 4000, 6000 Hz) separately for males and females. This high and low frequency grouping was responsive to one of the working hypotheses suggesting that hearing changes related to noise would be more evident at the high frequencies. Determination of the sum of ranks for the aforementioned mean differences indicating poorer hearing for the Playa del Rey group were, in fact, found significant in the high frequency group for both males and females. These results are summarized in Table XIX.

TABLE XVIII Differences Between Mean Hearing Levels in Decibels of Screened Groups of Residents from the Playa del Rey Test Group and the Pacific Palisades Control Group.[a]

AGE	EAR	MALE						FEMALE					
		TEST FREQUENCIES IN HERTZ (Hz)						TEST FREQUENCIES IN HERTZ (Hz)					
		500	1000	2000	3000	4000	6000	500	1000	2000	3000	4000	6000
10-17	R	-4.3	-2.3	-2.8	1.7	0.5	3.4	-0.5	-1.5	-4.4	-4.5	-3.7	-1.5
	L	0.1	-1.9	-3.5	-0.2	-1.5	6.7	-2.5	-3.8	0.0	-1.0	-2.0	-0.8
18-24	R	-1.2	-0.3	0.1	-0.5	-1.4	3.7	-5.7	-1.9	1.6	-2.8	-1.1	-4.0
	L	-5.0	-1.1	0.1	3.0	1.1	6.3	-2.2	-1.4	1.5	0.5	-0.7	-2.3
25-34	R	-2.3	5.9	-1.6	1.7	-5.1	-3.2	-5.2	-0.6	0.5	4.4	-3.7	1.5
	L	-0.2	0.00	1.0	2.8	-6.0	-2.3	-4.8	-2.0	-4.1	0.1	-0.8	8.5
35-44	R	3.6	1.6	-1.2	-2.6	-2.8	8.4	-0.4	2.8	1.3	2.4	2.3	3.7
	L	-1.8	2.4	-7.8	4.1	5.4	-7.4	-3.1	0.7	-0.7	1.6	0.0	5.9
45-54	R	1.7	-1.6	-3.6	0.8	8.0	19.7	-0.7	0.4	1.2	2.6	-0.2	4.2
	L	-5.4	-6.3	-0.3	2.9	4.0	11.4	-0.3	1.2	1.6	7.1	7.5	3.8
55-64	R	-8.9	-2.7	5.2	4.9	11.8	16.4	-6.1	3.7	3.14	2.6	2.7	-7.3
	L	-7.1	-1.8	2.6	3.1	-0.5	8.8	6.0	1.7	10.3	2.9	2.6	-1.9
65-74	R	20.0	17.4	32.3	37.3	19.3	19.6	-5.9	-3.1	3.8	8.9	14.7	2.8
	L	12.9	17.9	26.0	18.6	12.1	19.0	-1.6	-2.0	3.8	12.3	1.9	5.5

[a]Note: A positive difference indicates that the test group (PDR) had poorer hearing than control group (PP). A negative difference indicates the test group had better hearing than the control group.

TABLE XIX Summary of Sign Test Evaluations of Mean Differences and Standard Deviations for Hearing Levels of Playa del Rey and Pacific Palisades Community Residents.

	MALE		FEMALE	
	500 1000 2000 Hz	3000 4000 6000 Hz	500 1000 2000 Hz	3000 4000 6000 Hz
No. of Mean Differences in Direction Showing PDR with Poorer Hearing [a]	18 (out of total of 42)	30** (out of total of 42)	17 (out of total of 42)	25* (out of total of 42)
No. of Standard Deviations in Direction Showing PDR having greater Variability [b]	24 (out of total of 42)	30++ (out of total of 42)	34++ (out of total of 42)	25 (out of total of 42)

[a]Evaluated for statistical significance by Wilcoxen Signed-Rank Test (24) and found significant @ $p < .05$ for one-tailed test (*) and @ $p < .01$ for one-tailed test (**).

[b]Evaluated for statistical significance by simple sign test (24) and found significant @ $p < .01$ for one-tailed test (++).

Also shown in Table XIX are the results of a simple sign test evaluation (24) for the number of standard deviation values for the Playa del Rey group which exceed those found for the Pacific Palisades residents under comparable conditions as shown in Tables XVI and XVII. Directional trends toward more variable hearing levels are noted for the Playa del Rey group at the high frequencies for the males and at the low frequencies for the females.

These initial results offer some evidence for suggesting poorer as well as more variable hearing levels for the airport neighborhood residents. As already mentioned, however, the magnitudes of the actual differences in hearing levels between the airport and control test groups were neither great nor consistent across various age and sex groups. More extensive statistical analyses were thus undertaken to ascertain the significance of differences between the hearing levels of the two neighborhood groups. These consisted of separate three-factor (Neighborhood X Age X Sex) analyses of variance applied to the screened hearing data at each test frequency and ear. There were twelve such analyses whose individual summaries are tabled in Appendix II. An overall view of the findings from these separate evaluations is shown in Table XX. Significant differences associated with the neighborhood factor as a main effect are evident at some but not all of the high frequencies and even occur at one relatively low frequency. In some instances, these significant neighborhood differences in hearing levels occur for only one ear at a given frequency. Some significant interactions of the neighborhood factor with age and sex also appear, suggesting systematic age and sex variations in the hearing level differences between neighborhoods. These latter effects are specific to certain frequencies and ears and do not hold throughout. In fact, a clear pattern of significance for the neighborhood factor, either as a main or interaction effect, does not altogether emerge in Table XX. At most, the results only partially confirm the reliability of hearing level differences found between neighborhoods at the high frequences where noise related effects would seem most likely. The differences in hearing levels at the specific high frequency conditions. showing significant neighborhood effects were in directions revealing the airport neighbors to have poorer hearing.

Age and sex, as main effects, significantly influence hearing levels particularly at the high frequencies. Examination of the hearing levels pooled for these factors show, as reported elsewhere (25), increasing hearing level with advancing age and males to have poorer hearing than females.

TABLE XX Significant F-ratios for Main Effects and Interaction Terms Found in Separate 3-Factor Analyses of Variance of the Screened Hearing Data Performed at Each Test Frequency and Ear.

		Test Frequency (Hz)					
		500	1000	2000	3000	4000	6000
Neighborhood (N)	Right	1.84	15.86**	8.78**	8.24**	0.55	4.86*
	Left	0.64	2.81	4.94*	4.93*	1.42	1.96
Age (A)	Right	1.26	4.15**	11.48**	1.64	28.11**	20.79**
	Left	1.26	3.39**	1.31	24.09**	33.45**	24.88**
Sex (S)	Right	0.31	0.07	3.34	7.52**	16.68**	2.45
	Left	0.72	0.34	6.41*	15.43**	16.80**	10.76**
N x A	Right	1.56	1.78	3.10**	1.57	2.42*	1.05
	Left	2.39*	2.32*	2.77*	0.82	0.56	0.53
N x S	Right	0.00	2.29	3.16	1.87	5.35*	1.47
	Left	7.68**	2.64	7.90**	0.88	2.27	1.69
A x S	Right	2.20*	1.40	1.81	0.74	1.47	0.76
	Left	1.39	1.84	1.72	1.72	1.67	0.90
N x A x S	Right	2.60*	1.38	1.34	1.26	0.48	0.40
	Left	3.86**	1.38	1.69	0.44	0.88	1.05

* F-ratio significant $p < .05$
** F-ratio significant $p < .01$

CENTILE DISTRIBUTIONS OF HEARING DATA FOR THE AIRPORT AND CONTROL GROUPS

Several additional evaluations of the hearing level data obtained from the Playa del Rey and Pacific Palisades residents were undertaken to clarify further apparent differences. In this regard, Tables XXI-XXIV show centile distributions of hearing threshold levels by audiometric frequency, sex and ear for both the total and screened groups of residents sampled from the two neighborhoods. Indicated are hearing level values above or below which certain percentages of the individual hearing thresholds fall. For example, 25% of each test group had hearing threshold levels better than the values specified at the 25th centile; conversely 75% of the same group had threshold levels which were poorer than the values cited at this centile. The 50th centile represents the midpoint in the different tabled distributions and defines the median threshold level at the different test frequencies. Examination of Tables XXIII and XXIV shows the median levels for the screened Playa del Rey and Pacific Palisades data to be quite comparable, especially for frequencies below 3000 Hz. Differences in median hearing levels between these groups at frequencies 3000 Hz and above while notable are not large. Much more obvious are the differences between the Playa del Rey and Pacific Palisades values at the 75th and 95th centiles, again at the high frequencies.

Invariably higher hearing levels for the Playa del Rey listeners at these points indicate the presence of more deviant hearing thresholds in this group. Aside from the factor of aircraft noise exposure, another possible explanation for this latter finding may lie in the age make-up of the screened groups of neighborhood residents. The screened sample of Pacific Palisades includes more young persons than the Playa del Rey sample. As such, its distribution may be shifted toward more sensitive hearing levels and limited in spread. Centile distributions of the hearing data for the total or unscreened groups of Playa del Rey and Pacific Palisades residents also show differences akin to the screened data as described above (see Tables XXI-XXII.

COMPARISONS WITH NATIONAL HEALTH SURVEY ESTIMATES

Shown at the bottom of Tables XXI-XXIV are median hearing levels at different test frequencies and ears estimated for males and females ranging in age from 18 to 79 years based on the National Health Survey of 1960-1962 (NHS (25)). The median hearing levels observed for the Playa del Rey and Pacific Palisades groups in these same tables, both screened and unscreened, are generally more sensitive than the NHS values, especially at the higher frequencies.

More specific comparisons of the NHS estimates of typical hearing levels against those observed for the two test groups in this survey are plotted by age, sex, and ear in Figures 9 to 22. Generally, the screened mean hearing levels for both the airport neighbors and the control group are better (more sensitive) than median estimates from the NHS data at the high frequencies (Figures 9 to 15). These different sets of data show near similar threshold values at the low frequencies. Thus, the hearing levels for the Playa del Rey residents, though somewhat poorer than that

TABLE XXI Percentile Comparison of Hearing Levels in Decibels re 1969 ANSI Standard for Non-Screened Males by Ear and Frequency for Resident from the Test (PDR) and Control (PP) Neighborhoods. (PDR N=136; PP N=145)

CENTILE	LEFT EAR												RIGHT EAR											
	TEST FREQUENCY (HZ)												TEST FREQUENCY (HZ)											
	500		1000		2000		3000		4000		6000		500		1000		2000		3000		4000		6000	
	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP
05	4	6	-3	-3	-5	-4	-3	-3	-6	-3	-6	-5	2	4	0	-6	-4	-3	-3	-5	-5	-6	-2	-5
25	11	13	3	5	-1	1	4	3	4	4	11	2	8	11	7	6	-1	0	4	2	3	9	1	4
50	16	18	9	10	6	6	12	10	15	12	22	13	16	16	12	12	6	6	12	9	14	8	25	16
75	23	23	17	16	18	11	29	20	36	27	45	30	22	20	20	18	18	12	27	21	38	24	49	32
95	30	29	36	25	44	27	64	49	66	59	73	52	39	30	41	28	50	28	67	48	69	55	78	57
50[a]	13		7		11.5		21.5		28		36.5		14		7		9.5		19.5		26.0		34.5	

[a]Data from the National Health Survey (24).

TABLE XXII Centile Comparison of Hearing Levels in Decibels re 1969 ANSI Standard for Non-Screened Females by Ear and Frequency for Residents from the Airport Test (PDR) and Control (PP) Neighborhoods. (PDR N=132; PP N=164)

CENTILE	LEFT EAR												RIGHT EAR											
	TEST FREQUENCY (HZ)												TEST FREQUENCY (HZ)											
	500		1000		2000		3000		4000		6000		500		1000		2000		3000		4000		6000	
	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP
05	3	7	-2	-1	-4	-3	-2	-4	-6	-4	-8	-6	2	3	0	2	-3	-2	-5	-4	-5	-5	-8	-11
25	11	12	4	5	2	1	5	2	2	1	8	4	11	12	9	8	5	4	4	3	0	1	5	3
50	18	17	11	9	7	5	10	8	9	6	15	10	17	19	15	12	9	7	12	8	8	7	14	10
75	24	22	18	15	16	11	24	15	18	16	28	19	25	24	24	19	22	12	21	13	22	15	27	17
95	36	31	34	25	31	20	40	28	42	40	53	41	38	30	43	28	35	20	41	26	45	33	50	37
50[a]	13		6		8.5		11.5		11.0		23.5		14		7		8.5		11.5		11.0		22.5	

[a]Data from the National Health Survey (24).

TABLE XXIII Percentile Comparison of Hearing Levels in Decibels re 1969 ANSI Standard for Screened Males by Ear and Frequency for Residents from the Test (PDR) and Control (PP) Group Neighborhoods. (PDR N=83; PP N=77).

CENTILE	LEFT EAR												RIGHT EAR											
	TEST FREQUENCY (HZ)												TEST FREQUENCY (HZ)											
	500		1000		2000		3000		4000		6000		500		1000		2000		3000		4000		6000	
	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP
05	2	5	-3	-3	-5	-5	-4	-4	-6	-6	-7	-9	3	1	1	-1	-4	-3	-5	-6	-5	-6	-3	-8
25	10	11	1	2	-2	0	2	0	0	0	7	0	8	9	5	4	-1	-1	2	1	-2	0	7	0
50	14	16	8	7	5	4	11	7	11	8	15	10	15	15	11	10	5	4	9	6	8	5	14	8
75	20	20	12	13	12	10	26	15	28	16	36	16	20	20	16	16	12	9	18	12	24	12	32	18
95	27	28	24	21	35	19	50	31	59	41	56	34	29	30	27	24	34	18	54	25	55	35	67	35
50 [a]	13		7		11.5		21.5		28		36.5		14		7		9.5		19.5		26.0		34.5	

[a] Data f rom the National Health Survey (24).

TABLE XXIV Centile Comparison of Hearing Levels in Decibels re 1969 ANSI Standard for Screened Females by Ear and Frequency for Residents from the Test (PDR) and Control (PP) Groups. (PDR N=136; PP N=145).

CENTILE	LEFT EAR												RIGHT EAR											
	TEST FREQUENCY (HZ)												TEST FREQUENCY (HZ)											
	500		1000		2000		3000		4000		6000		500		1000		2000		3000		4000		6000	
	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP	PDR	PP
05	2	6	-3	-2	-5	-4	-4	-4	-6	-6	-8	-7	1	3	0	2	-3	-3	-5	-4	-6	-6	-10	-11
25	9	11	2	3	-1	0	3	1	-2	-1	3	2	8	11	7	6	-1	2	1	1	-3	-1	3	1
50	14	16	8	8	5	4	8	6	6	5	12	8	15	16	12	11	6	6	6	6	4	4	10	8
75	20	20	14	14	9	8	17	12	16	11	22	14	20	22	17	16	12	10	14	11	11	12	21	14
95	27	28	20	21	24	15	31	23	39	24	39	29	27	30	26	23	24	17	28	21	31	27	41	30
50[a]	13		6		8.5		11.5		11.0		23.5		14		7		8.5		11.5		11.0		22.5	

[a]Data from the National Health Survey (24).

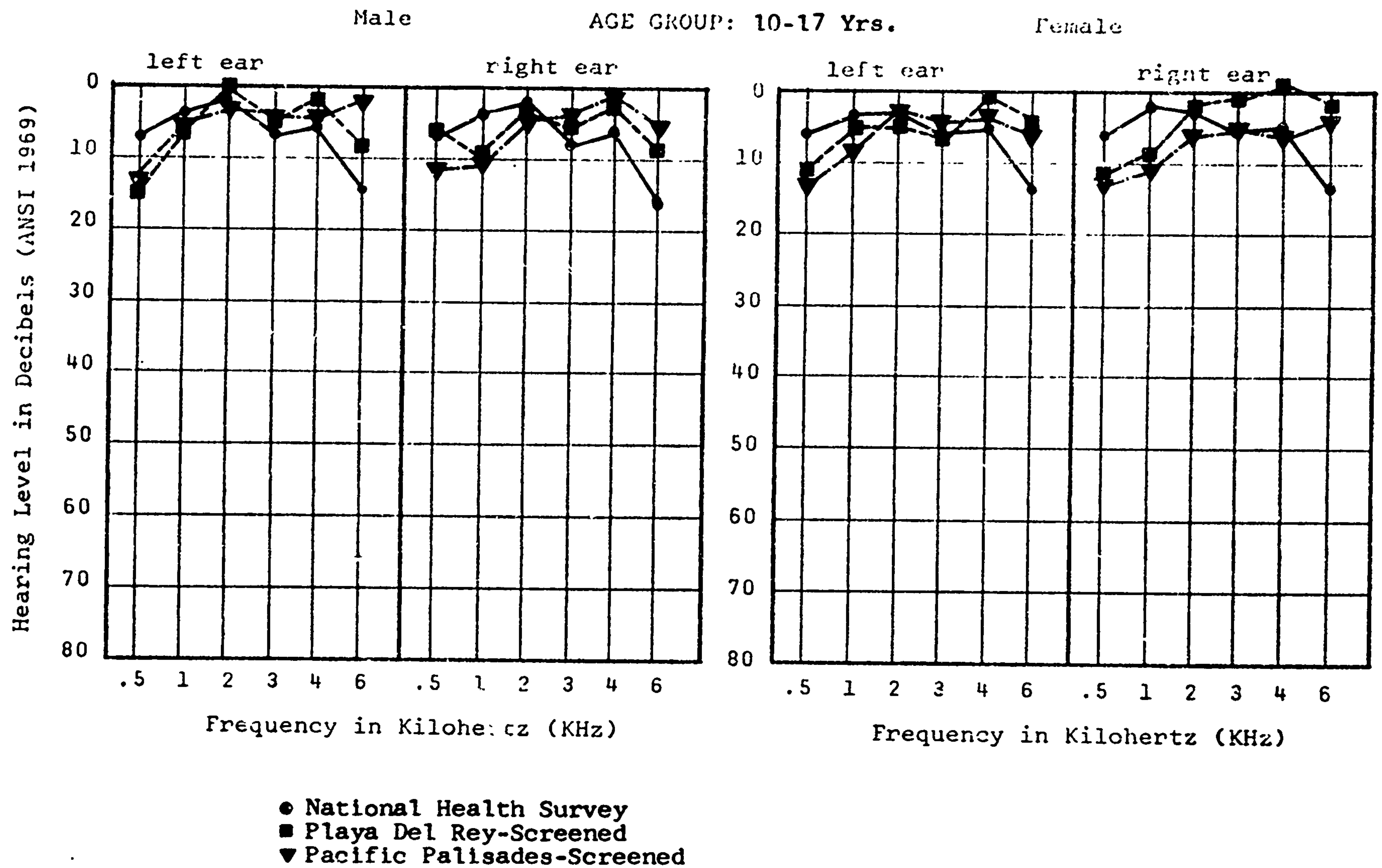

Figure 9. Comparison of Mean Hearing Levels for the Test and Control Groups with Estimates from the National Health Survey by Ear and Sex for the Age Group 10-17 Years. Screened Group Statistics.

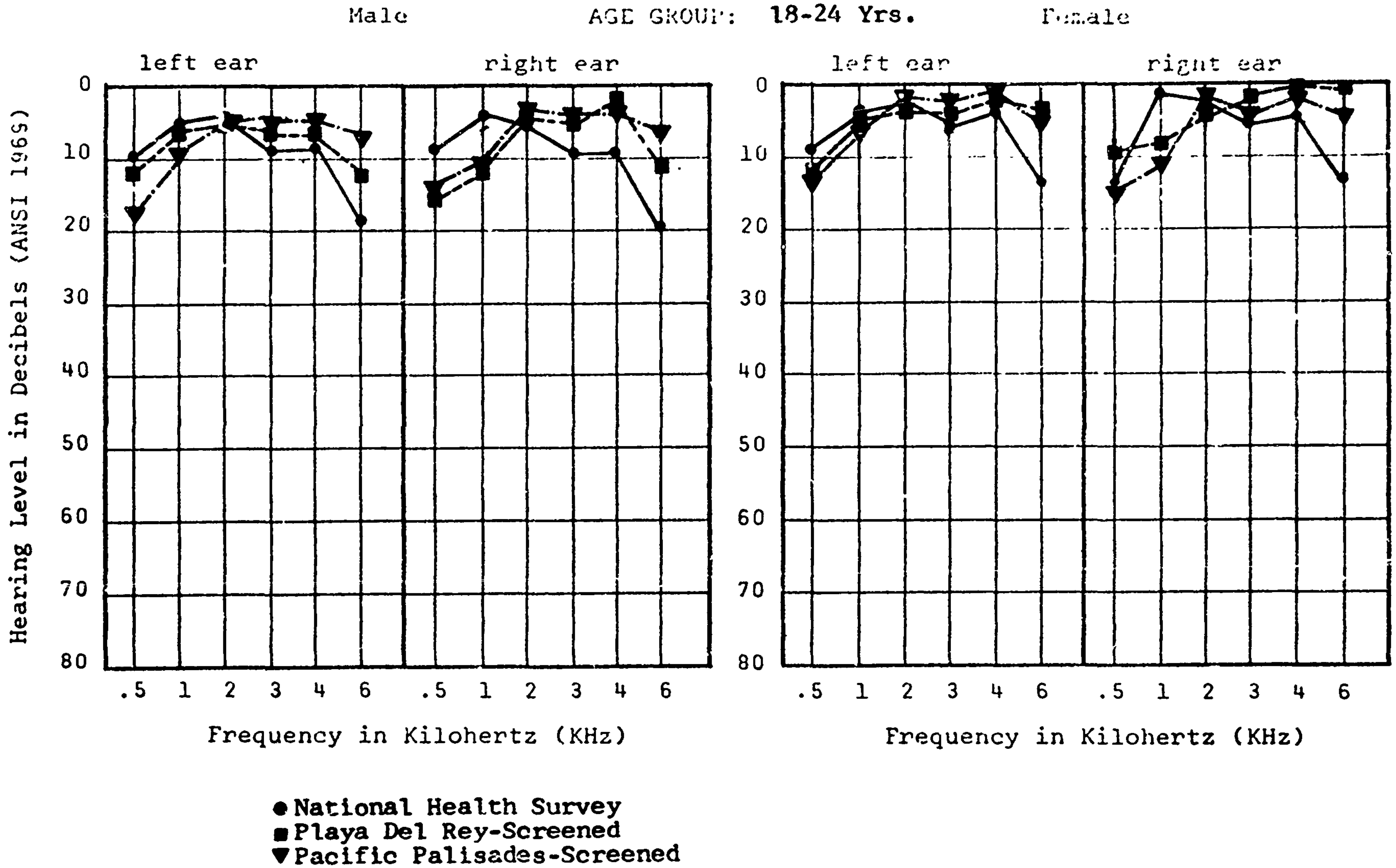

Figure 10. Comparison of Mean Hearing Levels for the Test and Control Groups with Estimates from the National Health Survey by Ear and Sex for the Age Group 18-24 Years. Screened Group Statistics.

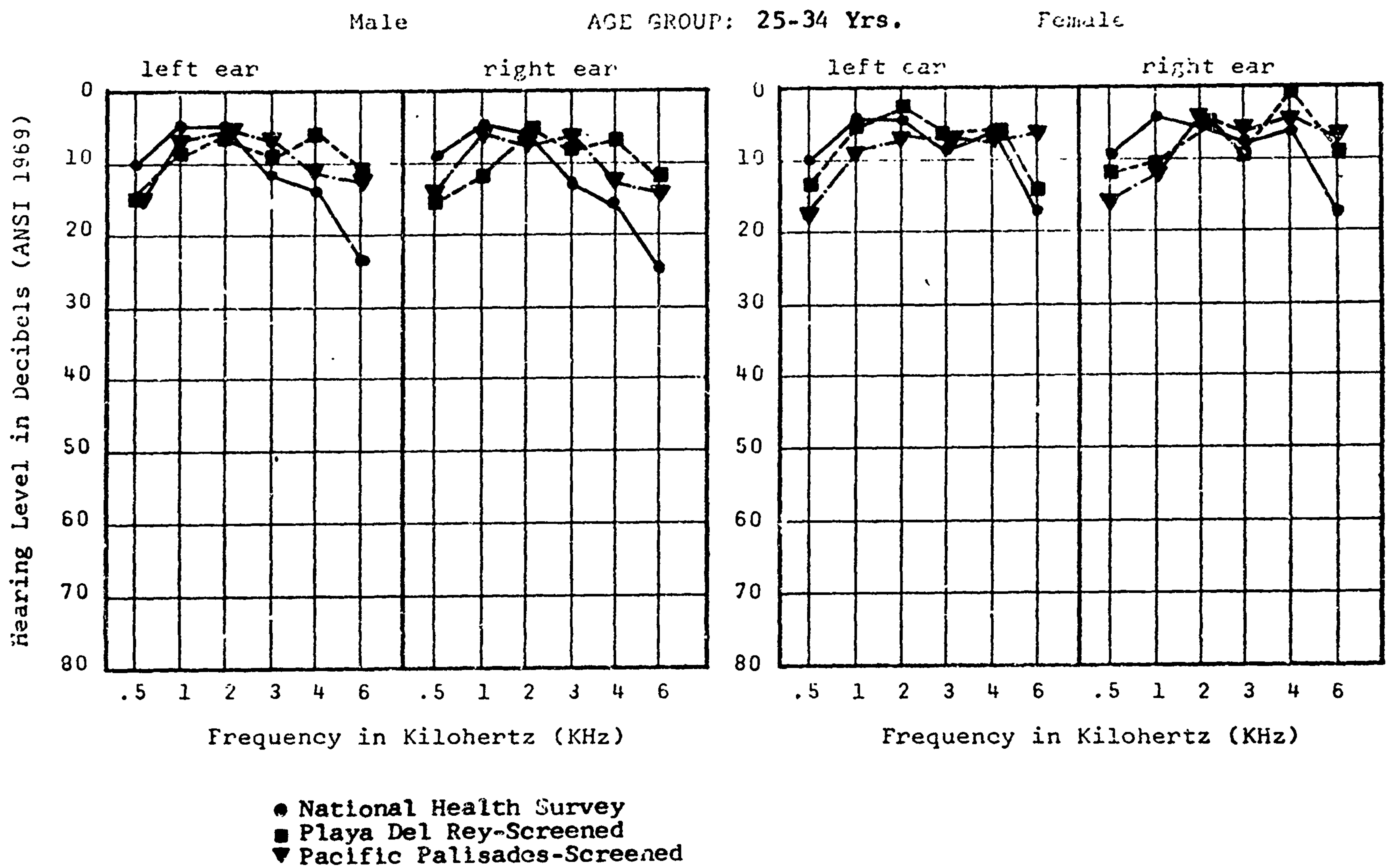

Figure 11. Comparison of Mean Hearing Levels for the Test and Control Groups with Estimates from the National Health Survey by Ear and Sex for the Age Group 25-34 Years. Screened Group Statistics.

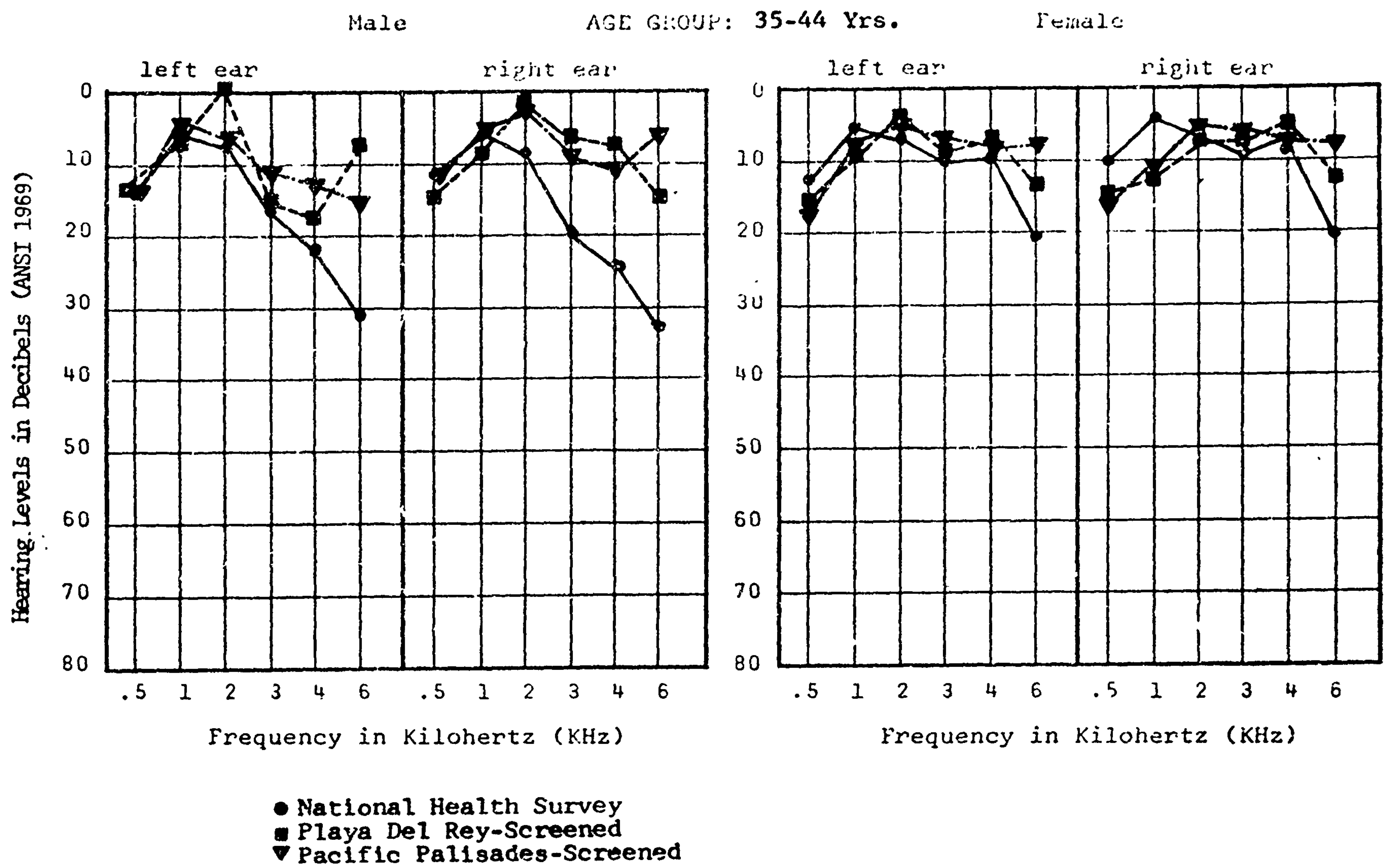

Figure 12. Comparison of Mean Hearing Levels for the Test and Control Groups with Estimates from the National Health Survey by Ear and Sex for the Age Group 35-44 Years. Screened Group Statistics.

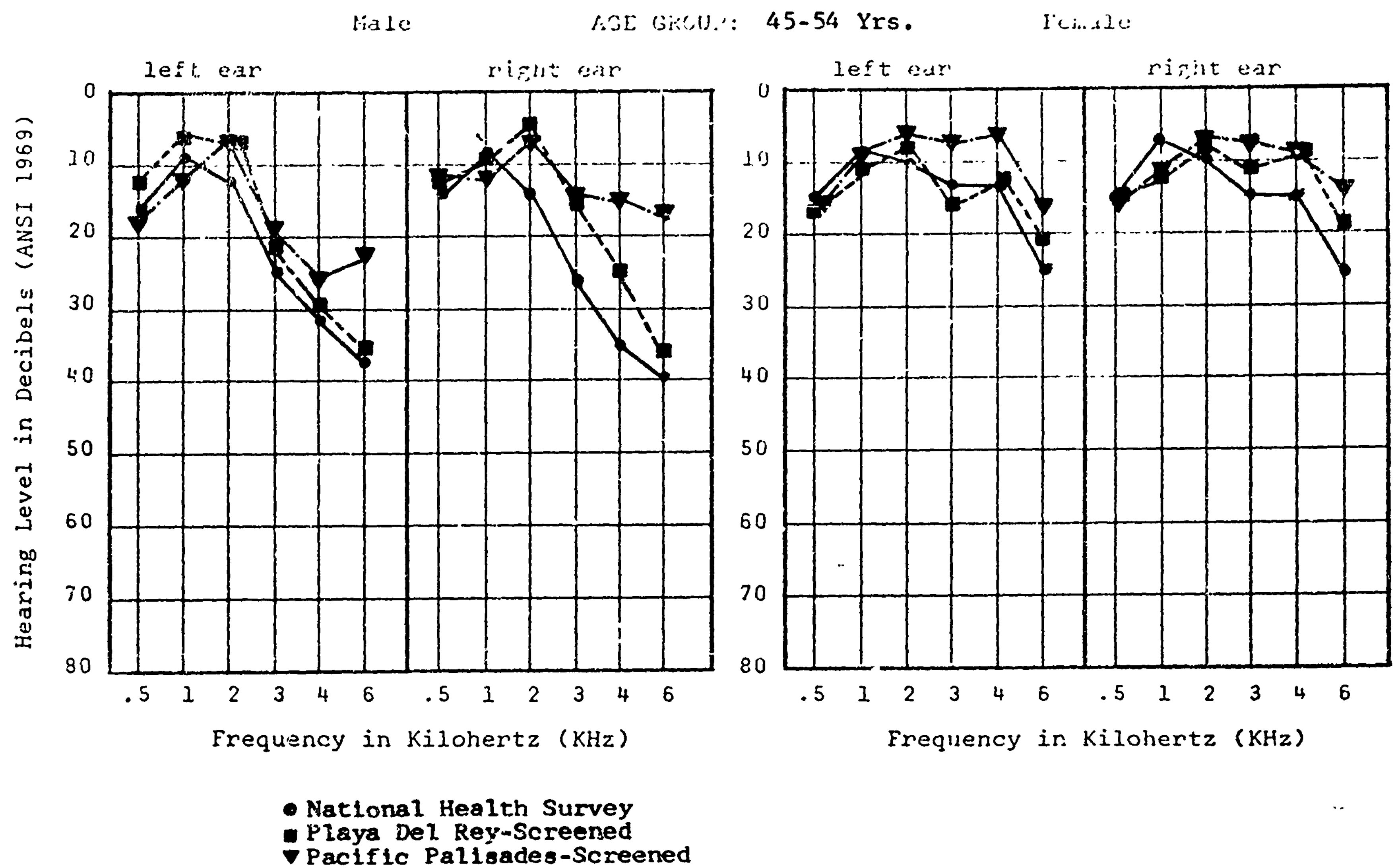

Figure 13. Comparison of Mean Hearing Levels for the Test and Control Groups with Estimates from the National Health Survey by Ear and Sex for the Age Group 45-54 Years. Screened Group Statistics.

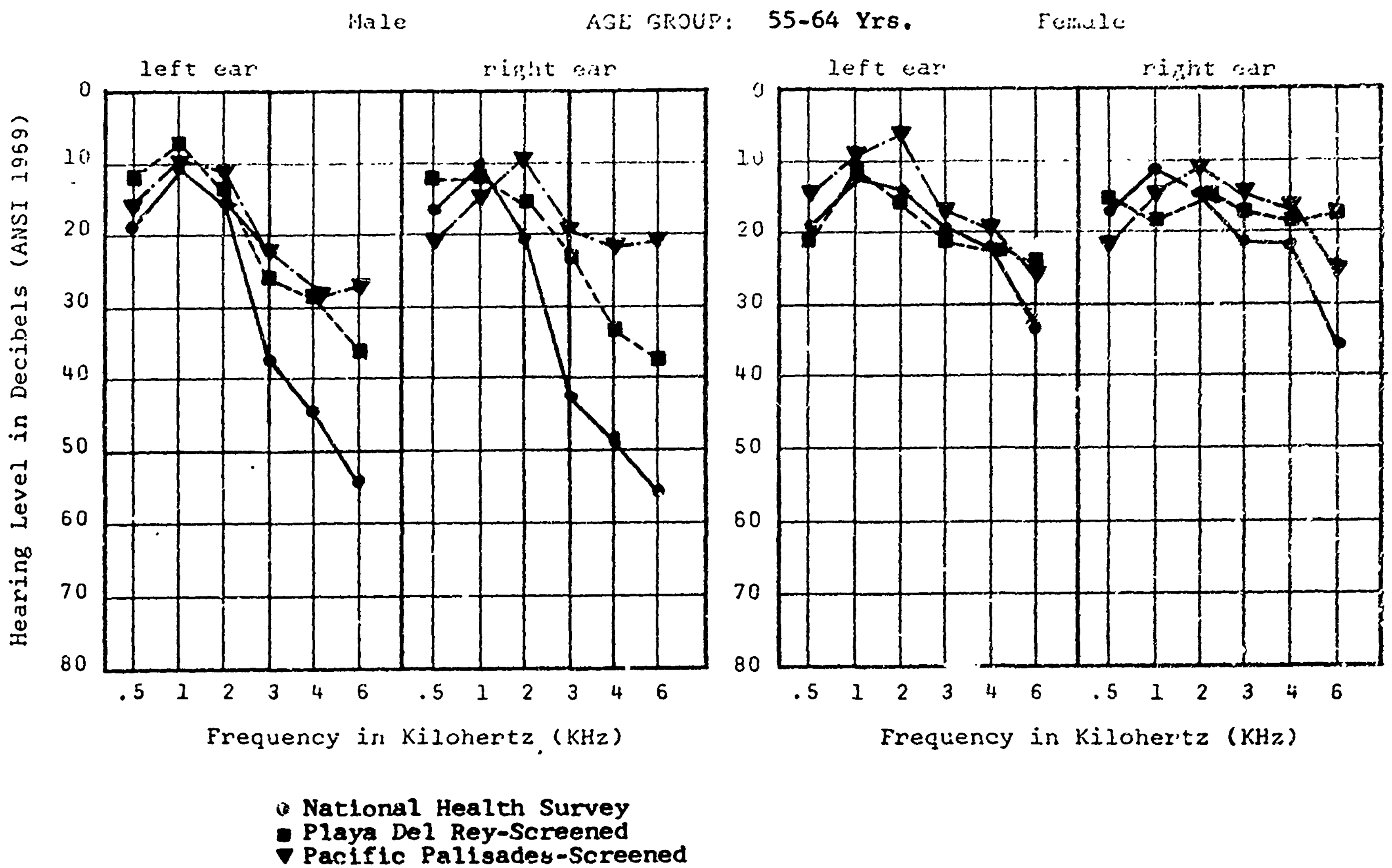

Figure 14. Comparison of Mean Hearing Levels for the Test and Control Groups with Estimates from the National Health Survey by Ear and Sex for the Age Group 55-64 years. Screened Group Statistics.

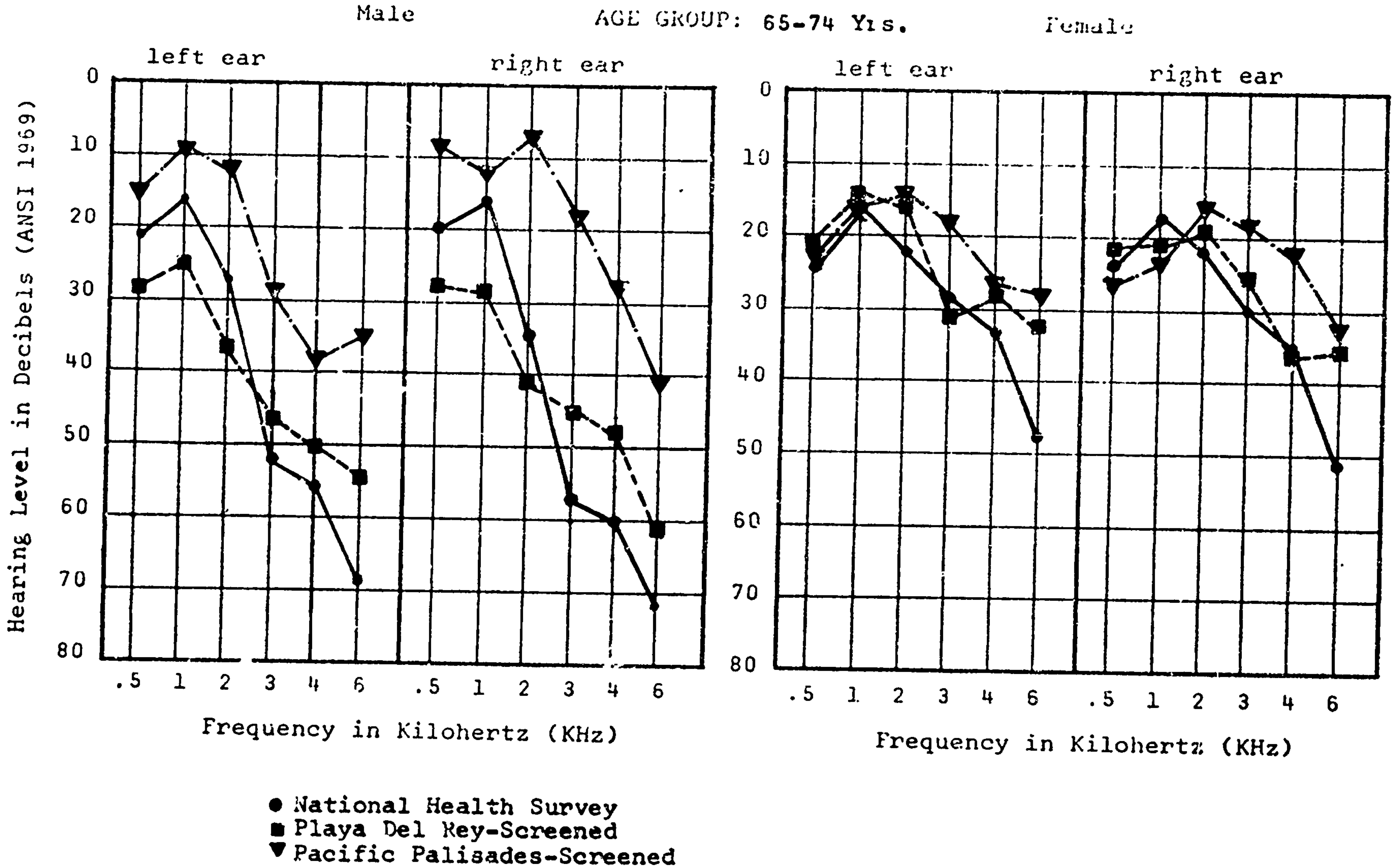

Figure 15. Comparison of Mean Hearing Levels for the Test and Control Groups with Estimates from the National Health Survey by Ear and Sex for the Age Group 65-74 Years. Screened Group Statistics.

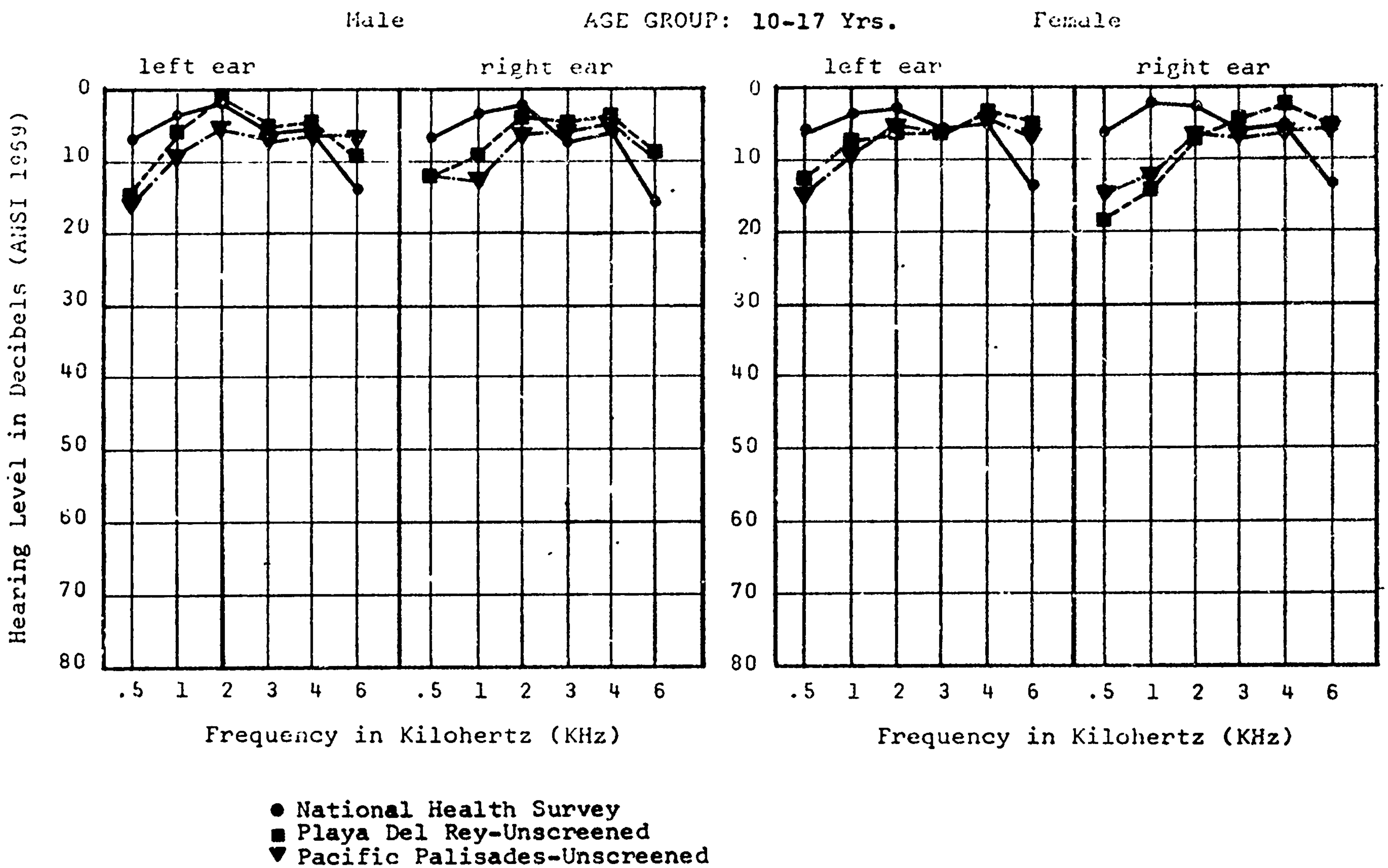

Figure 16. Comparison of Mean Hearing Levels for the Test and Control Groups with Estimates from the National Health Survey by Ear and Sex for the Age Group 10-17 Years. Total Group Statistics.

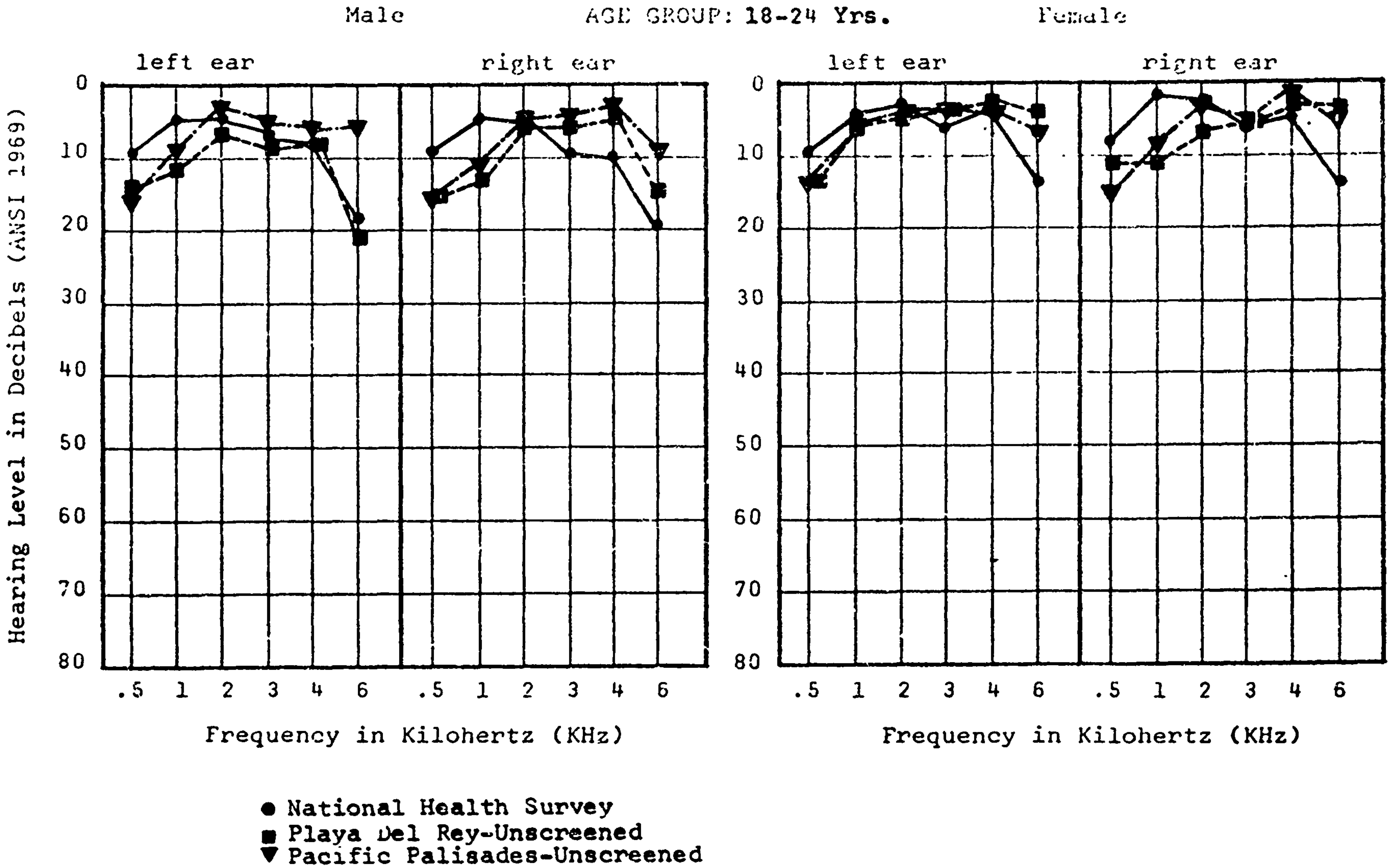

Figure 17. Comparison of the Mean Hearing Levels for the Test and Control Groups with Estimates from the National Health Survey by Ear and Sex for the Age Group 18-24 Years. Total Group Statistics.

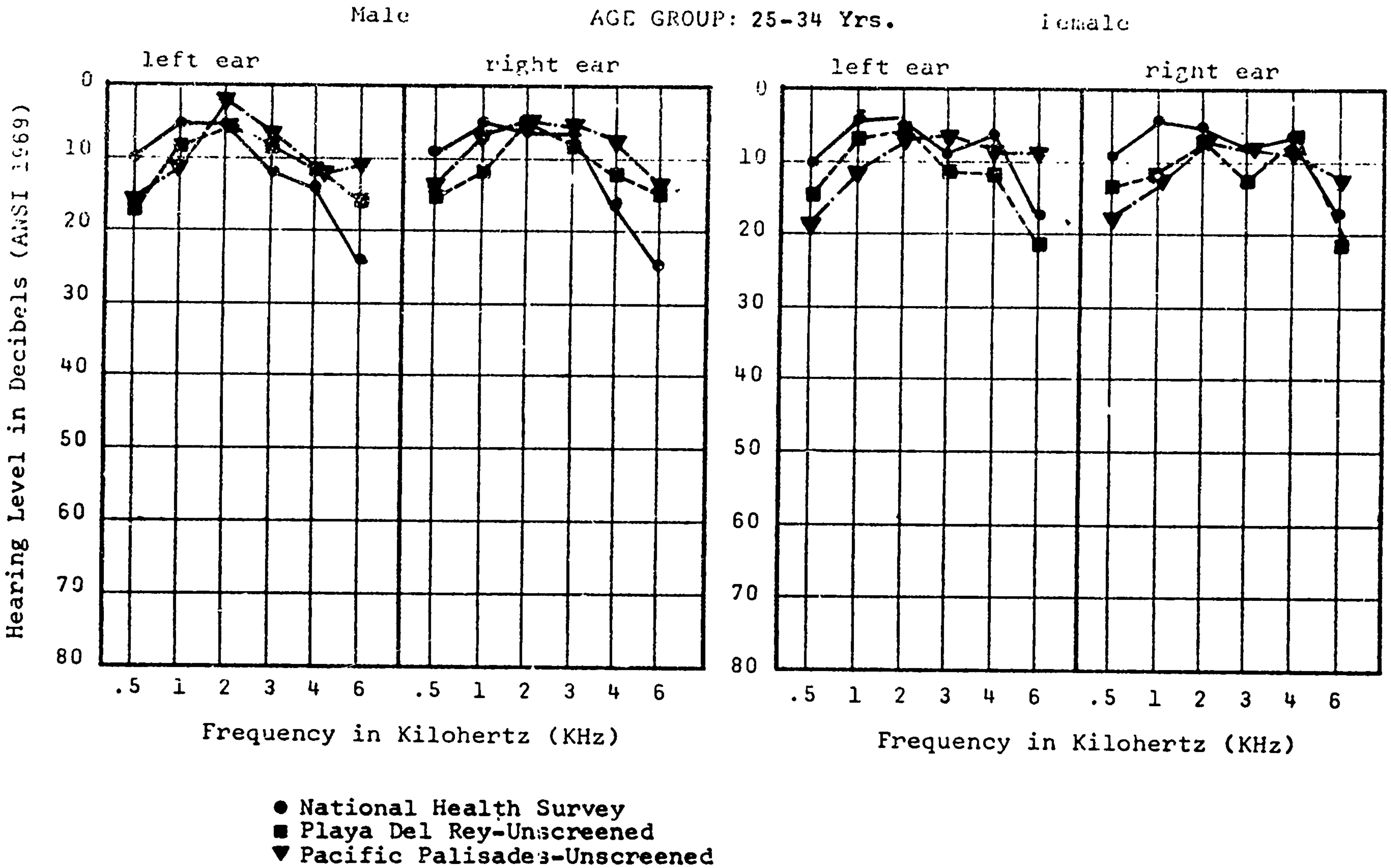

Figure 18. Comparison of Mean Hearing Levels for the Test and Control Groups with Estimates from the National Health Survey by Ear and Sex for the Age Group 25-34 Years. Total Group Statistics.

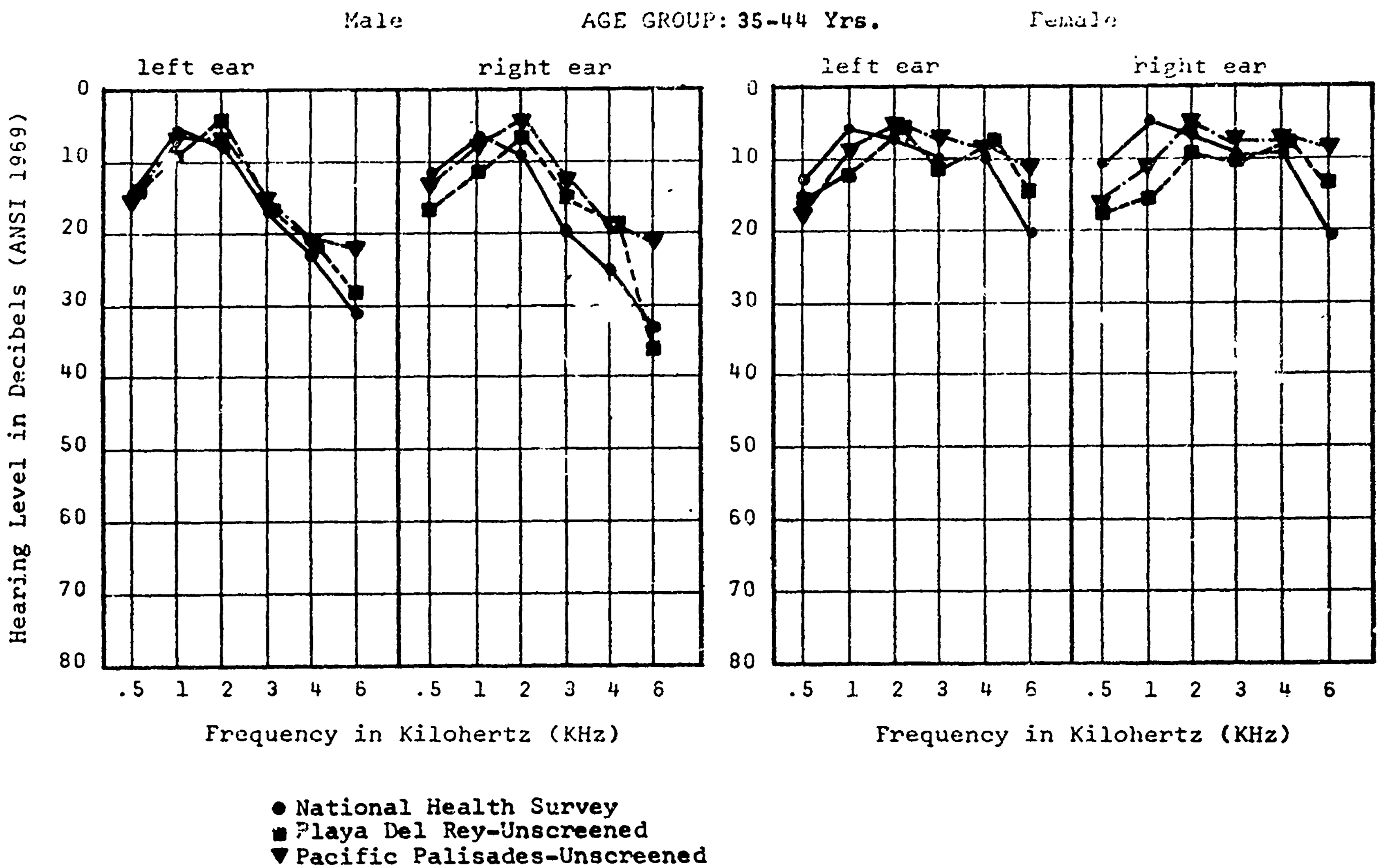

Figure 19. Comparison of Mean Hearing Levels for the Test and Control Groups with Estimates from the National Health Survey by Ear and Sex for the Age Group 35-44 Years. Total Group Statistics.

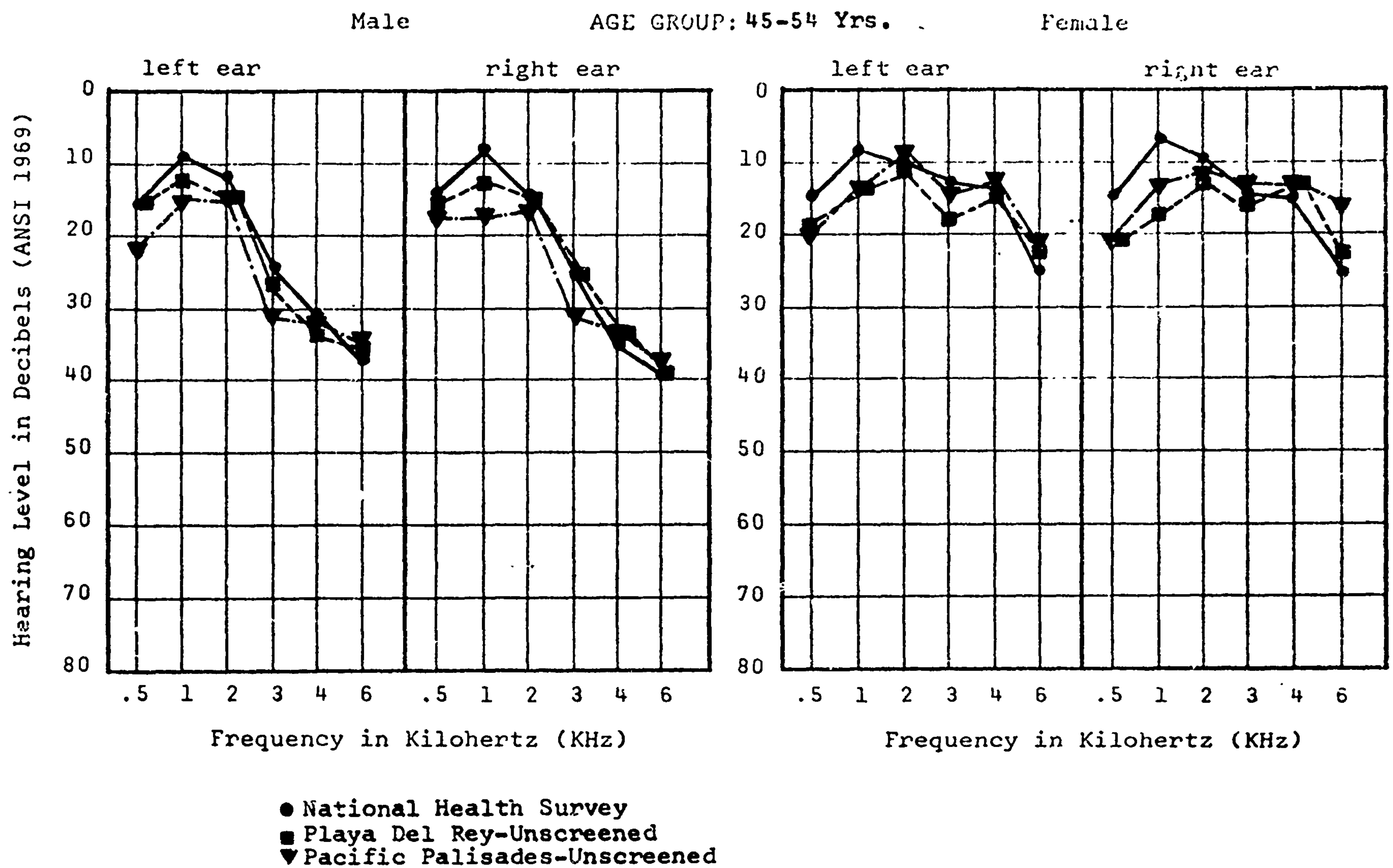

Figure 20. Comparison of Mean Hearing Levels for the Test and Control Groups with Estimates from the National Health Survey by Ear and Sex for the Age Group 45-54 Years. Total Group Statistics.

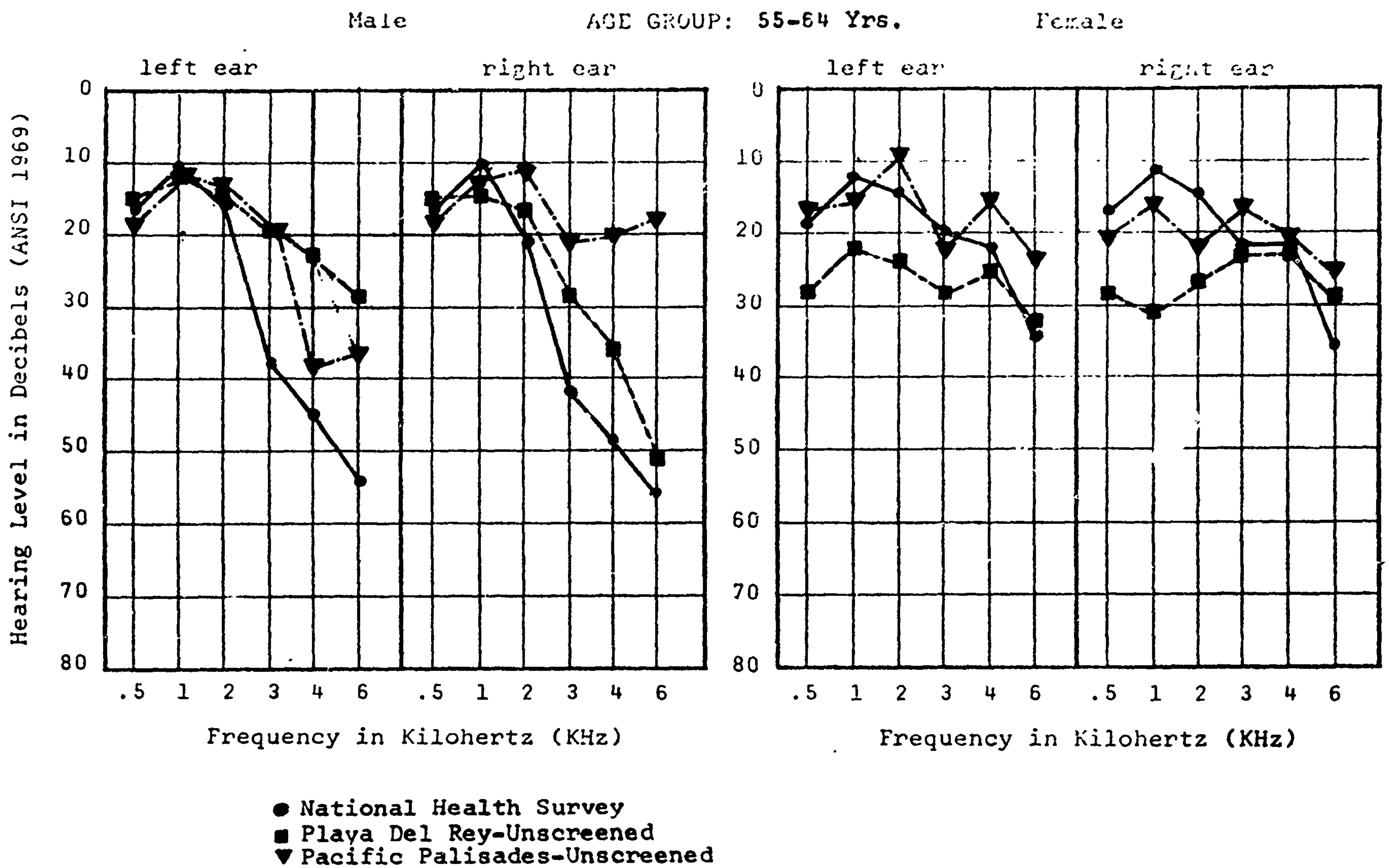

Figure 21. Comparison of Mean Hearing Levels for the Test and Control Groups with Estimates from the National Health Survey by Ear and Sex for the Age Group 55-64 Years. Total Group Statistics.

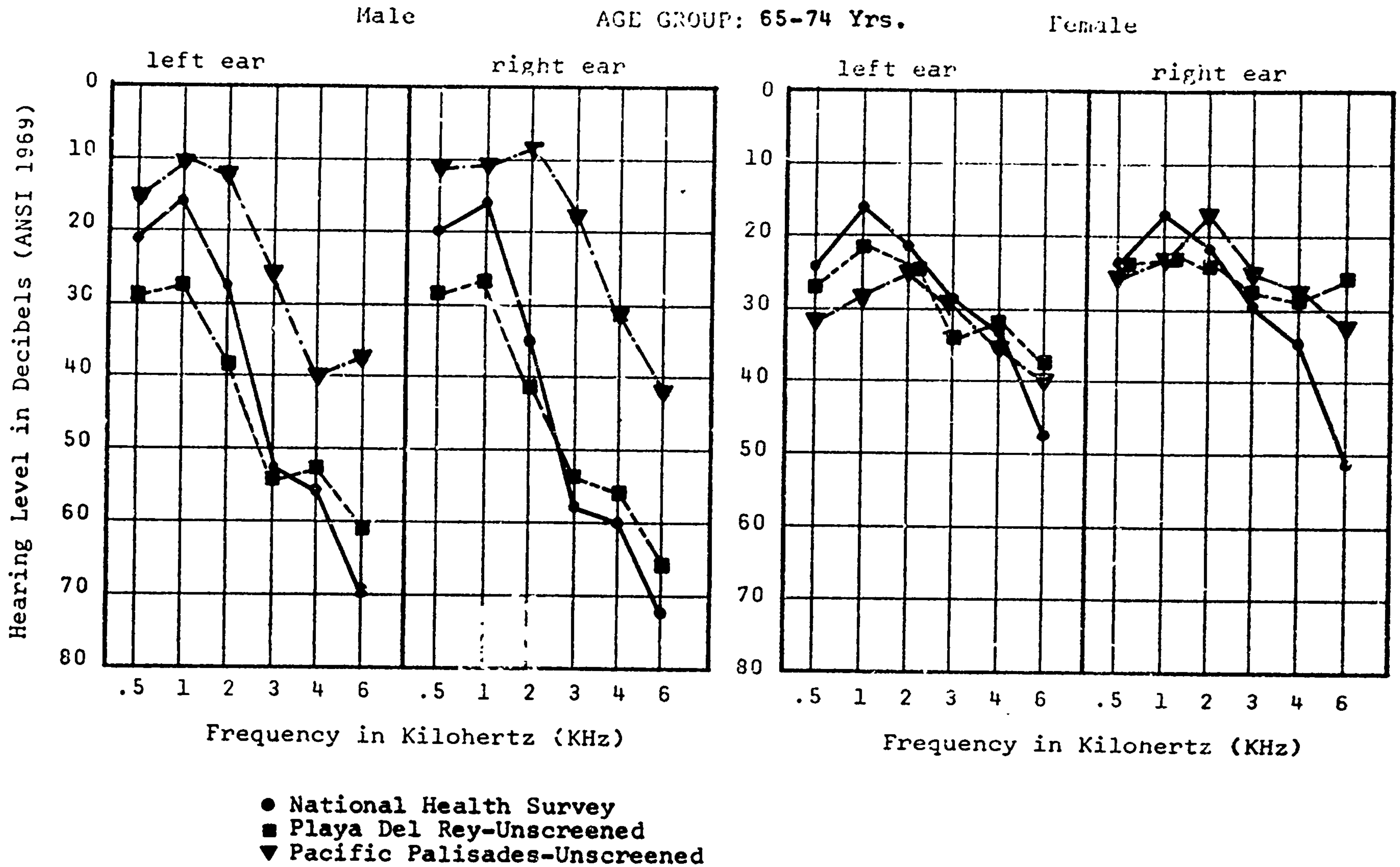

Figure 22. Comparison of Mean Hearing Levels for the Test and Control Groups with Estimates from the National Health Survey by Ear and Sex for the Age Group 65-74 Years. Total Group Statistics.

found for the control community, are still equal or better than typical values found nationally for the same age and sex groups.

The unscreened hearing level values for the two neighborhood groups are close to the NHS median levels at the high frequencies and are slightly poorer at the two lowest frequencies of 500 and 1000 Hz (Figures 16 to 22)[8]. This holds irrespective of sex, age and ear. That no exclusion criteria were used in the NHS to eliminate otologic disorders and other probable hearing loss cases may explain its better agreement with the unscreened data observed in this survey.

CORRELATIONS OF HEARING LEVELS WITH LENGTH OF RESIDENCY

Logically, if aircraft noise exposures were a causal factor in the poorer hearing displayed by the Playa del Rey group relative to the control, then systematic positive relationships should exist between length of residency in this airport neighborhood, i.e., the duration of exposure, and elevations in hearing level. Pearson product-moment correlations were computed to determine the degree of such correspondence for the screened subject groups in both Playa del Rey and the Palisades communities. The results are shown by age group and sex in Tables XXIV-SSV. No strong evidence is indicated in the Playa del Rey correlations. Indeed, coefficients were generally small and none statistically significant. Moreover, the direction of many such measures was counter to that expected. Differences in the amount of time actually spent in the neighborhood, or indoor versus outdoor activity, could have marred the strength of these possible correlations. In an attempt to evaluate further one of these aspects, two subsamples were drawn from the screened group of Playa del Rey residents each consisting of persons who had lived in the area ten or more years. One subsample however, was composed of those participants whose questionnaires indicated that they spend three or less days in the community whereas the other included residents who stated that they stay in the community six to seven days per week. Members of these two subsamples were otherwise matched one-to-one in terms of sex, age, and years of residency in the airport neighborhood. Table XXVII summarizes this evaluation. Differences in hearing levels between these two subgroups are largely equivocal despite the greater possibility for one group to receive a much greater amount of aircraft noise exposure. It is likely that the variable nature of the residents' activities over the years may also nullify the meaningfulness of this type of comparison. That is, more time could have been spent outdoors in the airport neighborhood five to ten years ago before the upsurge in jet air traffic. Those who spend most of their time at home now, may remain indoors longer, thus receiving an attenuated exposure to the aircraft sounds. The questionnaire proved inadequate to yield meaningful information bearing on these considerations. Under these circumstances, consideration of the means, variances, and distributions of hearing levels for the airport area residents relative to those of the

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8. The elevated hearing levels at 500 Hz and 1000 Hz may be an artifact of using circumaural headsets (Otocups) as opposed to standard supra-aural earpieces. The Otocups may inflate threshold levels at low frequencies by 2 - 5 dB (27).

TABLE XXV Pearson Product-Moment Correlations[a] Between Length of Residency in Years and Hearing Loss as a Function of Age Group and Sound Frequency for Screened Group Males.

AGE	PLAYA DEL REY						PACIFIC PALISADES					
	TEST FREQUENCY (HZ)						TEST FREQUENCY (HZ)					
	500	1000	2000	3000	4000	6000	500	1000	2000	3000	4000	6000
10-17	-.20	-.09	.05	-.18	-.27	-.21	.11	.07	-.06	-.08	.14	.05
18-24	-.28	-.15	-.10	-.24	-.22	.14	-.04	.09	.17	.10	.27	.23
25-34	-.09	.00	.25	.24	.16	-.09	.06	-.09	-.33	-.64	-.51	.01
35-44	-.30	-.19	-.08	-.08	-.07	.03	-.18	.01	.06	-.14	-.12	-.03
45-54	-.05	-.13	-.01	.04	-.06	-.16	.15	.18	.08	.20	.31	.29
55-64	.18	.17	.08	.05	.13	.08	-.46	-.21	-.18	-.33	-.13	-.39
65-74	-.36	-.47	-.53	.11	.05	.00	-.07	-.34	-.29	-.83	.86	.89

[a] A positive correlation means that higher hearing levels (greater losses) were associated with increased years of residency. A negative correlation indicates that higher hearing levels were associated with shorter lengths of residency in years. All noted correlations were insignificant.

TABLE XXVI Pearson Product-Moment Correlations[a] Between Length of Residency in Years and Hearing Loss as a Function of Age Group and Sound Frequency for Screened Group Females.

AGE	PLAYA DEL REY						PACIFIC PALISADES					
	TEST FREQUENCY (HZ)						TEST FREQUENCY (HZ)					
	500	1000	2000	3000	4000	6000	500	1000	2000	3000	4000	6000
10-17	.08	.26	-.16	.03	.05	.10	-.10	-.25	-.32	-.16	-.32	-.11
18-24	.28	.37	.24	.39	.34	-.14	-.17	-.46	-.12	-.39	-.40	-.12
25-34	.44	.22	-.20	.61	.46	.54	.00	.14	.09	-.06	.01	.04
35-44	.27	.18	.35	-.19	.03	-.28	.17	.17	.43	.34	.37	.24
45-54	-.52	-.53	-.49	-.51	-.46	-.29	.06	-.10	-.07	-.14	-.20	-.25
55-64	-.21	-.21	-.27	-.26	-.07	.15	-.17	-.18	-.11	.04	-.23	-.38
65-74	.30	.55	.59	.31	.40	.37	.47	.45	.42	.38	.44	.42

[a]A positive correlation means that higher hearing levels (greater losses) were associated with increased years of residency. A negative correlation indicates that higher hearing levels were associated with shorter lengths of residency in years. All noted correlations were insignificant.

TABLE XXVII Median Differences[a] in Decibels of Hearing Levels for Matched Subgroups of Playa del Rey Residents Spending Few and Many Days Per Week in their Community.

Median Differences in Hearing Levels (in dB)

Match-up of Subgroups		Left Ear						Right Ear					
		Test Frequency (Hz)						Test Frequency (Hz)					
		500	1000	2000	3000	4000	6000	500	1000	2000	3000	4000	6000
Male (N=9)													
6 or 7 days/wk Med. Age = 61 yr. (Range:30-71 yr.) Med. Residency=17 yr. (Range:10-23 yr.)	3 or less days/wk Med. Age = 61 yr. (Range:29-67 yr.) Med. Residency=20 yr. Range:11-27 yrs.)	1.0	-2.0	-1.0	4.0	1.0	-3.0	3.0	-2.0	-1.0	-4.0	-1.0	-15
Female (N=10)													
6 or 7 days/wk Med. Age = 31 yr. (Range:17-54 yr.) Med. Residency=17.5 yr. (Range:12-20 yr.)	3 or less days/wk Med. Age=30.5 yr. (Range:18-53 yr.) Med. Residency=17 yr. (Range:10-21 yr.)	4.5	2.5	-1.0	-4.0	7.0	-3.0	3.0	6.5	0.0	1.0	3.0	-3.0

[a]Positive difference signifies subgroup with more days per week in community to have relatively poorer hearing; negative difference means subgroup with few days per week in community has relatively poorer hearing. All differences were statistically insignificant based upon evaluations by a Wilcoxen matched pair signed ranks test (24).

control neighborhood remain the only basis for making judgments about possible aircraft noise effects on the ear.

Correlation coefficients tabled for the Pacific Palisades group also show no systematic relations emerging between length of residency and measured hearing levels, and none were expected (see Tables XXV, XXVI).

SUMMARY AND CONCLUSIONS

A three-part hearing evaluation consisting of a discrete frequency audiometric test, an otologic check, and a questionnaire referencing aural history and related matters was administered to residents drawn from two neighborhoods in greater Los Angeles, California. One neighborhood lay at the West boundary of Los Angeles International Airport and had been subjected over the years to frequent takeoff noise of jet aircraft. On-site measurement of the aircraft sound levels in this area found them to range from 76 to 101 dBA with typical median values of 88 dBA. Determinations of the volume of air traffic indicated that more than 500 takeoffs per day currently affect this region. Additional information gathered showed that the community aircraft noise exposure has become more extensive over a period of ten years due to a continuous increase in the number of jet aircraft operations out of Los Angeles International Airport.

The second (control) neighborhood was similar to the aircraft test community in demography but essentially free of significant jet aircraft sounds or other major noise intrusions. Noise measurements here, even during peak activity hours, rarely exceeded 60 dBA and averaged 50 dBA or less.

Hearing threshold data acquired from the control neighborhood residents, screened to eliminate cases of suspected ear disorders or extraneous noise induced hearing loss, were compared with similarly screened data from the airport neighborhood to determine if any differences in hearing threshold levels existed between the two groups. Evaluations were also made using the National Health Survey estimates of hearing threshold levels. The principal results of these analyses are described below:

1. At the more noise sensitive higher frequencies on the audiogram (3000, 4000, 6000 Hz), differences between the mean hearing levels of the airport and control groups were small but tended to be in directions suggesting poorer hearing for the airport neighbors. Differences in hearing levels between the two groups at low frequencies on the audiogram (500, 1000, 2000 Hz) were equivocal.

2. The hearing data for the airport group were relatively more variable displaying more spread in their distributions and more deviant values.

3. Despite apparent poorer hearing levels for the airport group relative to the control group, such threshold values were still equal to, or even better at certain frequencies, than those reported in the National Health Survey (1960-1962). Absence of screening criteria for excluding abnormal ears in the latter survey could be the basis for this finding.

4. Correlations between length of residency in the airport neighborhood and hearing levels did not show close correspondence as might be expected if aircraft noise exposure were a causal factor for the poorer hearing in the airport neighbors. Comparisons of the hearing levels of matched subgroups of these persons who spend few versus many days per week in their community also failed to yield significant differences in the expected direction. Variability in living habits over the years, coincident with the upsurge in jet aircraft traffic, may confound or obscure possible associations among the aforementioned factors.

In terms of concluding statements, the observed aircraft noise levels in the airport neighborhood are generally less intense or short-lived in comparison to those found in mechanized workplaces where evidence for noise-induced hearing loss among workers is well documented. Nevertheless, ratings of these community aircraft noise conditions against industrial hearing conservation criteria cannot dismiss the risk of possible hearing loss for those residents who may be exposed daily, perhaps frequently throughout the day, over a period of years. Evidence of such hearing changes in this study is suggested by differences between the hearing threshold levels of the airport neighbors and a control group at certain test frequencies. The actual amounts of loss indicated by these differences, however, are neither substantial nor statistically significant in all instances. Moreover, the overall findings cannot definitively isolate aircraft noise exposure as the cause of these apparent hearing level differences. Other unique features of the particular airport neighborhood surveyed may have been responsible though not identified in the questionnaire data or other information which was collected. Conclusions about aircraft noise as a possible cause of hearing changes in residents in airport neighborhoods will have to await the outcome of still more definitive surveys in other communities with a long history of such exposures. It is recommended that these additional evaluations be undertaken.

APPENDIX I

QUESTIONNAIRE AND CODING FORMAT

OMB No. 85-S70025
Approval Expires May 31, 1971

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
Environmental Health Service
Environmental Control Administration
Bureau of Occupational Safety and Health
Cincinnati, Ohio 45202

COMMUNITY NOISE AND HEARING STUDY

ASSURANCE OF CONFIDENTIALITY

The U.S. Public Health Service hereby gives its assurance that your identity and your relationship to any information obtained by reason of your participation in the Community Noise and Hearing Study will be kept confidential in accordance with PHS regulations (42 CFR 1.103(a)) and will not otherwise be disclosed except as specifically authorized below. A copy of this regulation will be made available to you upon request.

Marcus M. Key, M.D.

Director, Bureau of Occupational
Safety and Health
ECA, EHS

CONSENT

I hereby voluntarily agree to participate in the Community Noise and Hearing Study which will be conducted by the U.S. Public Health Service. It has been explained to me that in addition to my answering a questionnaire, there will be a routine medical examination of my ears and a standard hearing test. I have been advised that I may withdraw from this study at any time if I so desire.

Signature _______________ Date _______________

AUTHORIZATION TO RELEASE MEDICAL INFORMATION

I hereby request the U.S. Public Health Service to inform my personal physician should there be any evidence from this study of an active ear disorder.

Dr. _______________

Street _______________

City _______________ State _______________ Zip Code _______________

Telephone _______________

Signature _______________ Date _______________

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Name of Community ______________
Participant Number ______________

(Note: Questions 1-8 below are to be completed by staff interviewer any-time before hearing exam).

(1) Name: ____

(2) Address: ____

(3) Age: ______________________ (4) Sex: ______________________

(5) Residential Background:
   a. When did you move into this community? ______________________
   b. In what other communities have you lived for at least 3 years?

Location (City/State)	Type of Area (Urban/Suburban/Rural)	Period of Residence (From (Year)-To (Year))

   i ____

   ii ____

   iii ____

   iv ____

   v ____

   c. Of the following which do you consider the least attractive feature of your present community? (Check one) Crowding _____; Litter _____; Noise _____; Smoke and Soot _____.
   d. Is your present community quieter than the previous ones in which you have lived? Yes _____ No _____
   e. Typically, how many days during the week are you at home (or in the community) for most of the day? (Circle one) 1 - 2 - 3 - 4 - 5 - 6 - 7
   f. Typically, how much time per day do you spend outdoors when you are home? (Number of hours) ______________
   g. What period of the day do you most frequently spend outdoors when you are at home? (Circle one) Morning - Afternoon - Evening
   h. What is the loudest type of sound you hear most frequently when outdoors in this community? ______________
   i. Is this the loudest type of sound you also hear most frequently when indoors? Yes _____ No _____
   If not, specify loudest noise heard indoors. ______________

Name of Community ________________
Participant Number ________________

j. Does your home have any special features such as double-pane windows, extra insulation of attic-ceiling areas, weather-stripped door and window frames? If so, specify as noted below:

i Double pane windows. Yes _____ No _____
ii Acoust. insulation of attic-ceiling areas. Yes _____ No _____
iii Weather-stripping of door and window frames. Yes _____ No _____
iv Other (specify) ________________________________
v Were these features purposely installed to reduce the passage of outdoor noise into your home? Yes _____ No _____

k. Is your home centrally air-conditioned? Yes _____ No _____
l. If not, do you use individual window units? Yes _____ No _____

(6) Occupational Conditions

a. Is your present job a noisy one in that you have to shout to have your fellow workers hear what you are saying? Yes _____ No _____
b. Have you ever held a job where you had to shout to be heard even at close distances? Yes _____ No _____
c. If yes to (a) or (b), we should like to list these jobs and the number of years in which you were employed in them. We shall start with the most recent one.

	Type of Job (Describe)	Place of Work (plant, hospital, school)	Source of Noise	Period of Employment (From (Year)-To (Year))	Did you use Ear Protection
i					
ii					
iii					
iv					
v					

(7) Military Service:

a. Were you in military service? Yes _____ No _____ Specify Service ________
b. What was your unit assignment? (e.g., infantry, armored) ____________
c. Did you fire weapons? Yes _____ No _____
d. If so, what kinds? ________________________________
e. For how long? ________________________________
f. Were you exposed to weapon noise even if you did not fire them? Yes _____ No _____
g. If so, for how long? ________________________________
h. Were you exposed frequently to noise from aircraft, armored vehicles or large engines? Yes _____ No _____
i. If so, for how long? ________________________________

Name of Community ________
Participant Number ________

(8) Non-Occupational Noise Exposure:
   a. Have you used firearms as a civilian? Yes _____ No _____
   b. If so, what kind(s) of weapons? ________
   c. When (e.g., childhood, 10 years ago, currently)? ________
   d. For how many years have you used such weapons? ________
   e. How frequently? ________
   f. How many rounds per year? ________
   g. Do you routinely wear ear protectors when you fire weapons? Yes _____ No _____
   h. Do you participate in hobbies or other off-job activities that are typically noisy or have loud sounds (e.g., motorbike racing, rock-roll music playing, machine work, etc.)? Yes _____ No _____
   i. If so, specify? ________
   j. For how many years have you taken part in this hobby or activity? ________
   k. How frequently? (daily, weekly, monthly) ________
   l. What types of vehicles or forms of transportation have you used at least three days a week? (check as many as apply and record other required information)

Vehicle		For how many years at this frequency	Average Time per Day in Vehicle	Actual Frequency of Use Per Week
Automobile	____			
Bus	____			
Truck	____			
Motorcycle	____			
Streetcar	____			
Subway	____			
Airplane	____			
Motorboat	____			
Other (Specify)	____			

(Note: Questions 9 and 10 below will be completed by staff medical doctor just before scheduled hearing test).

(9) Relevant Medical History:
   Have you had any of the following:

	Yes	No
(a) Head noises	( )	( )
(b) Deafness in family	( )	( )
(c) Hearing test	( )	( )
(d) Treatment by MD for ear trouble	( )	( )
(e) Running ears	( )	( )
(f) Earaches	( )	( )
(g) Hearing aid	( )	( )
(h) Do you routinely take any medication?	( )	( )
What type and for what reason? ________		
(i) Do you think you have normal hearing?	( )	( )

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Name of Community ________________
Participant Number ________________

(10) Otologic Check: Normal ( ) Abnormal ( )

(a) Perforation of drum head	R(ight)	L(eft)	Elaborative Comments:
(b) Drainage from ear	R	L	________________
(c) Malformation or growth in ear	R	L	________________
(d) Ear occlusion	R	L	________________
(e) Ear disease	R	L	________________
(f) Other (specify)	R	L	________________

(Note: Question 11 below will be completed by audiometrist just before subject takes hearing exam).

(11) Time and Duration of Last Notable Exposure:
(a) What was your most recent exposure to loud noise (specify, e.g., horn, airplane, workplace, gunshot, etc.)? ________________
(b) How long ago did this exposure take place? ________________(in days)
(c) How long did the exposure last? __________ __________(minutes or hours)

(12) Hearing Level Data:

Pure Tone I

Date:	Tester:	
Time:	Station:	
Freq	R	L
250		
500		
1000		
1500		
2000		
3000		
4000		
6000		
8000		

Pure Tone II (optional)

Date:	Tester:	
Time:	Station	
Freq	R	L
250		
500		
1000		
1500		
2000		
3000		
4000		
6000		
8000		

ITEM	POSSIBLE VALUE	EXPLANATION
1. Subject Number	Integer Number	Sequential Numbering keyed to scoring sheets
2. Age	Integer Number	Subject Age
3. Sex	1, 2	Male =1, Female = 2
4. Residency Length	Integer Number	Length of residency in community, in years.
5. Previous Community Type	1, 2, 3	Type of community lived in previously, 1=Urban, 2=Suburban, 3=Rural.
6. Disliked Element	1, 2, 3, 4	Element least liked in present neighborhood.
7. Community Noise Rating	1, 2	Present community quieter than previous community lived in=1, Noisier =2.
8. Weekly Exposure Time	1-7	No. days normally spent at home or in immediate community.
9. Daily Exposure Time	0 - 24	No. hours per day usually spent outdoors when in community.
10. Daily period	1, 2, 3	Daily period usually spent outdoors 1=morning, 2=Afternoon, 3=evening.
11. Prominent Sound Outdoors	1, 2, 3, 4	Most prominent sound heard when outdoors, 1=Aircraft, 2=Traffic, 3=Neighborhood Noises, 4=Other.
12. Prominent Sound Indoors	1, 2, 3, 4	Same as above - indoors
13. Sound Proofing Extent	1, 2, 3	Extent to which residence is soundproofed. 1=none, 2=Minimal treatment, 3=Heavy treatment, double glazing, etc

Questionnaire Data Coding Format

	ITEM	POSSIBLE VALUE	EXPLANATION
14.	Job Rating	Integer Number	Number of years spent on job with severe noise exposure-rated negative if ear protection used.
15.	Military Service Rating	1, 2, 3	Rating of military noise exposure: 1=No military service, 2=Service with little or no noise exposure, 3=Service with moderate to severe exposure.
16.	Non-Occupational Noise Rating	1, 2, 3	Rating of Non-Occupational, non-military noise exposure rating; 1=no exposure, 2=minimal exposure from hobby, outdoors activities etc., 3=moderate to severe exposure.
17.	Vehicle Noise Exposure Rating	1, 2, 3	Rating of noise exposure history due to operation of various types of vehicles: 1=no exposure or exposure to automobile only, 2=minimal exposure to noisy vehicles, 3=moderate to severe exposure.
18.	Medical History	1, 2	Medical history rating with regard to Ear problems: 1=No known or minimal medical problems, 2=rating if medical history judged to be such that hearing damage could have occurred.
19.	Otologic Exam Rating	1, 2	Rating resulting from otologic exam of each subject: 1=no abnormalities or non-functional abnormalities, 2=functional abnormalities.
20.	Exclusion Flag	1, 2	1=Subject to be included in analyses, 2=subject abnormal in some respect (see section on Screening Criteria).
21.	Test Station Number	1,2,3,4,5,6	Number of instruments used for audiometric purposes.

Questionnaire Data Coding Format

ITEM	POSSIBLE VALUE	EXPLANATION
22.–27. Hearing Levels of the Left Ear	Integer Number	Uncorrected hearing levels read from audiometeric records.
28.–33. Hearing Levels of the Right Ear	Integer Number	Uncorrected hearing levels read from audiometric records.

Questionnaire Data Coding Format

APPENDIX II

SUMMARY TABLES FOR ANALYSES OF VARIANCE

ANALYSIS OF VARIANCE[a] OF HEARING LEVELS
BY NEIGHBORHOOD, AGE, AND SEX
LEFT EAR - 500 Hz

Source of Variance	df	Mean Square	F-Ratio
Neighborhood (N)	1	.0125	0.64
Age (A)	6	.0246	1.26
Sex (S)	1	.0140	0.72
N x A	6	.0464	2.39*
N x S	1	.1490	7.68**
A x S	6	.0271	1.39
N x A x S	6	.0749	3.86**
Error	336	.0193	----

* significant $p < .05$
** significant $p < .01$

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[a] See Anderson and Bancroft (29) for a description of this variance analysis. For this analysis, individual subject hearing data were expressed in log transformations to reduce apparent non-homogeneity of variance among the sample cells constituting the matrix.

ANALYSIS OF VARIANCE[a] OF HEARING LEVELS
BY NEIGHBORHOOD, AGE, AND SEX
LEFT EAR - 1000 Hz

Source of Variance	df	Mean Square	F-Ratio
Neighborhood (N)	1	.0900	2.81
Age (A)	6	.1085	3.39**
Sex (S)	1	.0108	0.34
N x A	6	.0741	2.32*
N x S	1	.0846	2.64
A x S	6	.0588	1.84
N x A x S	6	.0443	1.38
Error	336	.0320	-----

* significant $p < .05$
** significant $p < .01$

[a]See Anderson and Bancroft (29) for a description of this variance analysis. For this analysis, individual subject hearing data were expressed in log transformations to reduce apparent non-homogeneity of variance among the sample cells constituting the matrix.

ANALYSIS OF VARIANCE[a] OF HEARING LEVELS
BY NEIGHBORHOOD, AGE, AND SEX
LEFT EAR - 2000 Hz

Source of Variance	df	Mean Square	F-Ratio
Neighborhood (N)	1	.1975	4.94*
Age (A)	6	.0525	1.31
Sex (S)	1	.2561	6.41*
N x A	6	.1107	2.77*
N x S	1	.3160	7.90**
A x S	6	.0688	1.72
N x A x S	6	.0676	1.69
Error	336	.0400	-----

* significant $p \leq .05$
** significant $p \leq .01$

[a]See Anderson and Bancroft (29) for a description of this variance analysis. For this analysis, individual subject hearing data were expressed in log transformations to reduce apparent non-homogeneity of variance among the sample cells constituting the matrix.

ANALYSIS OF VARIANCE[a] OF HEARING LEVELS
BY NEIGHBORHOOD, AGE, AND SEX
LEFT EAR - 3000 Hz

Source of Variance	df	Mean Square	F-Ratio
Neighborhood (N)	1	.2201	4.93*
Age (A)	6	1.0755	24.09**
Sex (S)	1	.6887	15.43**
N x A	6	.0365	0.82
N x S	1	.0395	0.88
A x S	6	.0770	1.72
N x A x S	6	.0197	0.44
Error	336	.0446	-----

* significant $p < .05$
** significant $p < .01$

---

[a]See Anderson and Bancroft (29) for a description of this variance analysis. For this analysis, individual subject hearing data were expressed in log transformations to reduce apparent non-homogeneity of variance among the sample cells constituting the matrix.

ANALYSIS OF VARIANCE[a] OF HEARING LEVELS
BY NEIGHBORHOOD, AGE, AND SEX
LEFT EAR - 4000 Hz

Source of Variance	df	Mean Square	F-Ratio
Neighborhood (N)	1	.0738	1.42
Age (A)	6	1.7373	33.45**
Sex (S)	1	.8725	16.80**
N x A	6	.0293	0.56
N x S	1	.1180	2.27
A x S	6	.0870	1.67
N x A x S	6	.0456	0.88
Error	336	.0519	-----

** significant $p < .01$

---

[a]See Anderson and Bancroft (29) for a description of this variance analysis. For this analysis, individual subject hearing data were expressed in log transformations to reduce apparent non-homogeneity of variance among the sample cells constituting the matrix.

ANALYSIS OF VARIANCE[a] OF HEARING LEVELS
BY NEIGHBORHOOD, AGE, AND SEX
RIGHT EAR - 6000 Hz

Source of Variance	df	Mean Square	F-Ratio
Neighborhood (N)	1	.2017	4.86*
Age (A)	6	.8620	20.79**
Sex (S)	1	.1016	2.45
N x A	6	.0436	1.05
N x S	1	.0608	1.47
A x S	6	.0317	0.76
N x A x S	6	.0164	0.40
Error	336	.0415	------

* significant $p < .05$
** significant $p < .01$

[a] See Anderson and Bancroft (29) for a description of this variance analysis. For this analysis, individual subject hearing data were expressed in log transformationsto reduce apparent non-homogeneity of variance among the sample cells constituting the matrix.

ANALYSIS OF VARIANCE[a] OF HEARING LEVELS
BY NEIGHBORHOOD, AGE, AND SEX
RIGHT EAR - 500 Hz

Source of Variance	df	Mean Square	F-Ratio
Neighborhood (N)	1	.0414	1.84
Age (A)	6	.0285	1.26
Sex (S)	1	.0071	0.31
N x A	6	.0352	1.56
N x S	1	.0000	0.00
A x S	6	.0496	2.20*
N x A x S	6	.0587	2.60*
Error	336	.0226	----

*significant $p < .05$

[a]See Anderson and Bancroft (29) for a description of this variance analysis. For this analysis, individual subject hearing data were expressed in log transformations to reduce apparent non-homogeneity of variance among the sample cells constituting the matrix.

ANALYSIS OF VARIANCE[a] OF HEARING LEVELS
BY NEIGHBORHOOD, AGE, AND SEX
RIGHT EAR - 1000 Hz

Source of Variance	df	Mean Square	F-Ratio
Neighborhood (N)	1	.4819	15.86**
Age (A)	6	.1261	4.15**
Sex (S)	1	.0022	0.07
N x A	6	.0542	1.78
N x S	1	.0696	2.29
A x S	6	.0426	1.40
N x A x S	6	.0420	1.38
Error	336	.0304	-----

** significant $p < .01$

---

[a]See Anderson and Bancroft (29) for a description of this variance analysis. For this analysis, individual subject hearing data were expressed in log transformations to reduce apparent non-homogeneity of variance among the sample cells constituting the matrix.

ANALYSIS OF VARIANCE[a] OF HEARING LEVELS
BY NEIGHBORHOOD, AGE, AND SEX
RIGHT EAR - 2000 Hz

Source of Variance	df	Mean Square	F-Ratio
Neighborhood (N)	1	.3335	8.78**
Age (A)	6	.4358	11.48**
Sex (S)	1	.1270	3.34
N x A	6	.1177	3.10**
N x S	1	.1199	3.16
A x S	6	.0686	1.81
N x A x S	6	.0511	1.34
Error	336	.0380	----

**significant $p < .01$

---

[a]See Anderson and Bancroft (29) for a description of this variance analysis. For this analysis, individual subject hearing data were expressed in log transformations to reduce apparent non-homogeneity of variance among the sample cells constituting the matrix.

ANALYSIS OF VARIANCE[a] OF HEARING LEVELS
BY NEIGHBORHOOD, AGE, AND SEX
RIGHT EAR - 3000 Hz

Source of Variance	df	Mean Square	F-Ratio
Neighborhood (N)	1	.3422	8.24**
Age (A)	6	.0682	1.64
Sex (S)	1	.3121	7.52**
N x A	6	.0654	1.57
N x S	1	.0777	1.87
A x S	6	.0306	0.74
N x A x S	6	.0524	1.26
Error	336	.0415	----

**significant $p < .01$

[a]See Anderson and Bancroft (29) for a description of this variance analysis. For this analysis, individual subject hearing data were expressed in log transformations to reduce apparent non-homogeneity of variance among the sample cells constituting the matrix.

ANALYSIS OF VARIANCE[a] OF HEARING LEVELS
BY NEIGHBORHOOD, AGE, AND SEX
RIGHT EAR - 4000 Hz

Source of Variance	df	Mean Square	F-Ratio
Neighborhood (N)	1	.0308	0.55
Age (A)	6	1.5713	28.11**
Sex (S)	1	.9332	16.68**
N x A	6	.1350	2.42*
N x S	1	.2988	5.35*
A x S	6	.0824	1.47
N x A x S	6	.0266	0.48
Error	336	.0559	----

* significant $p < .05$
** significant $p < .01$

[a] See Anderson and Bancroft (29) for a description of this variance analysis. For this analysis, individual subject hearing data were expressed in log transformations to reduce apparent non-homogeneity of variance among the sample cells constituting the matrix.

ANALYSIS OF VARIANCE[a] OF HEARING LEVELS
BY NEIGHBORHOOD, AGE, AND SEX
LEFT EAR - 6000 Hz

Source of Variance	df	Mean Square	F-Ratio
Neighborhood (N)	1	.0795	1.96
Age (A)	6	1.0084	24.88**
Sex (S)	1	.4363	10.76**
N x A	6	.0216	0.53
N x S	1	.0686	1.69
A x S	6	.0367	0.90
N x A x S	6	.0424	1.05
Error	336	.0405	-----

* significant $p<.05$
** significant $p<.01$

---

[a] See Anderson and Bancroft (29) for a description of this variance analysis. For this analysis, individual subject hearing data were expressed in log transformations to reduce apparent non-homogeneity of variance among the sample cells constituting the matrix.

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